



KENNEDY SPACE CENTER'S

SPACEPORT

m a g a z i n e



OSIRIS-REx ARRIVES!

RESTRICTED
AREA

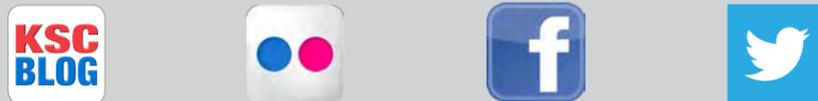
KENNEDY SPACE CENTER'S SPACEPORT MAGAZINE CONTENTS

- 4.....OSIRIS-REx Spacecraft arrives
- 8.....Weld points will protect astronauts during launch phases
- 10.....Thornton leads upgrade of Ground Special Power
- 14.....Tests simulate Space Launch System platforms
- 18.....College students help NASA on its journey to Mars
- 23.....Alabama team takes top robotic honors
- 24.....Upgrades to Launch Pad 39B flame trench
- 27.....Engineer employs art, science to design cockpits
- 30.....Starliner test article joined to complete first hull
- 32.....Students develop innovative robots in first Swarmathon
- 36.....Students trade school day for workday at KSC
- 38.....TOSC Safety Week focuses on culture of caring
- 44.....Hall of Fame welcome pair of space shuttle astronauts
- 49.....Gemini IX crew finds 'Angry Alligator' in Earth orbit

Front Cover: NASA's OSIRIS-REx spacecraft begins to rotate on a spin table during a weight and center of gravity test inside the Payload Hazardous Servicing Facility at Kennedy Space Center in Florida. The spacecraft is being prepared for its upcoming launch, targeted for Sept. 8 aboard a United Launch Alliance Atlas V rocket.

Back Cover: "Views of Our Planets" Forever stamps featuring iconic images of the planets in our solar system, including the well-known "Blue Marble" photo of Earth are now available at a post office near you!. Also, new "Pluto Explored" Forever stamps commemorating the July 2015 flyby of Pluto by NASA's New Horizons spacecraft also are being issued for online purchase.

To get the latest Kennedy Space Center updates, follow us on our **Blog, Flickr, Facebook and Twitter.**



THE SPACEPORT MAGAZINE TEAM

Editorial	Writers Group	Creative Group
Editor.....Frank Ochoa-Gonzales	Anna Heiney	Bob Granath
Assistant Editor.....Linda Herridge	Kay Grinter	Linda Herridge
Copy Editor.....Kay Grinter	Steven Siceloff	Lynda Brammer
		Matthew Young
		Greg Lee

NASA'S LAUNCH SCHEDULE

Date: June 18, 5:10 a.m. EDT
Mission: Undocking and Landing of Expedition 47 Crew
Description: Undocking of the Soyuz TMA-19M spacecraft from the Rassvet module and landing in Kazakhstan of the Expedition 47 crew.
<http://go.nasa.gov/rpDbqR>

Date: June 24, 2:42 a.m. EDT
Mission: Launch of Expedition 48 Crew
Description: Launch of the Expedition 48 crew on the Soyuz MS-01 spacecraft from the Baikonur Cosmodrome in Kazakhstan to the International Space Station.
<http://go.nasa.gov/1VHuSAV>

Date: July 16, 1:32 a.m. EDT
Mission: SpaceX CRS-9 Launch
Description: An uncrewed SpaceX Dragon spacecraft, carrying crew supplies and station hardware, will lift off on a Falcon 9 rocket from Space Launch Complex 40 at Cape Canaveral Air Force Station.

Date: Sept. 8
Mission: OSIRIS-REx
Description: The mission will study Benu, a near-Earth asteroid that is about one-third of a mile across. OSIRIS-REx will bring a small sample back to Earth for study. As planned, the spacecraft will reach its asteroid target in 2018 and return a sample to Earth in 2023.
<http://go.nasa.gov/1ItsRkl>

Date: Oct. 14
Mission: Geostationary Operational Environmental Satellite-R Series (GOES-R)
Description: The advanced spacecraft and instrument technology used on the GOES-R series will result in more timely and accurate forecasts and warnings.
<http://go.nasa.gov/1YubP2g>

National Aeronautics and Space Administration

I am KENNEDY SPACE CENTER

ALI SHAYKHIAN

I am a customer relationship manager in the IT Technical Integration Office, supporting the Engineering Directorate. In my role, I have the opportunity to review customers' IT needs, requirements, issues or challenges, then offer ideas and insights to achieve the best possible solutions. I started my career as a University of Central Florida professor, then worked as a NASA contractor, and finally joined NASA in April 2000. In 2003, I was elected as a National Administrator Fellowship Program (NAFP) fellow. My fellowship involved conducting STEM-related research and helping minority students in science and technology at Bethune-Cookman University. In addition to my regular responsibilities, I am an active member of the KSC Speakers Bureau. Through the bureau, I am able to bring the space program into classrooms. I have witnessed many K-12 students' excitement and enthusiasm firsthand, and it is constant encouragement to me and is why speaking to students is a priority in my life. I often receive handwritten notes from students after my visit. Here are a few excerpts: "Dear Dr. Ali, thanks for letting every one shoot rockets. I can't wait for you to come back again. Sincerely, Evan." "Thank you Dr. Ali for the fun rocket experiment. I liked when we built the rocket and I think it was fun and awesome. Love, Monica." I have received hundreds of notes like this that reflect the importance of how NASA impacts students' lives in small ways that can grow into life-changing moments. I encourage all of us to reach out to students and ignite that spark in the next scientist, engineer or astronaut. I am delighted to share what I do with the community. Working for NASA has been the most enjoyable experience in my professional life.



OSIRIS-REx

Spacecraft arrives

BY FRANK OCHOA-GONZALES



Tucked into a shipping container, NASA's OSIRIS-REx spacecraft is unloaded from an Air Force C-17 cargo aircraft on the Shuttle Landing Facility runway at Kennedy Space Center. The spacecraft traveled from Lockheed Martin's facility near Denver, Colorado to Kennedy to begin processing for its upcoming launch, targeted for Sept. 8 aboard a United Launch Alliance Atlas V rocket. OSIRIS-REx will be the first U.S. mission to sample an asteroid, retrieve at least two ounces of surface material and return it to Earth for study. This asteroid, Bennu, may hold clues to the origin of the solar system and the source of water and organic molecules found on Earth. Photo credit NASA/Bill White

NASA's OSIRIS-REx spacecraft is revealed after its protective cover is removed inside the Payload Hazardous Servicing Facility at Kennedy Space Center. Photo credit: NASA/Dimitri Gerondidakis



The spacecraft that will perform NASA's Origins Spectral Interpretation Resource Identification Security – Regolith Explorer mission, known as OSIRIS-REx, arrived at Kennedy Space Center from Buckley Air Force Base near Denver on May 20 aboard an Air Force C-17 at the Shuttle Landing Facility.

OSIRIS-Rex, which came out of the shipping container May 21, will go onto a rotation fixture on May 23 and have a spin test May 24-25. It then will be hoisted onto a dolly May 26 for other upcoming activities. A partial solar array deployment test is scheduled on May 31.

“This team has done a phenomenal job of assembling and testing the spacecraft,” said Dante Lauretta, principal investigator for OSIRIS-REx at the University of Arizona, Tucson. “As we begin the final preparations for launch, I am confident that this spacecraft is ready to perform its science operations at Bennu. And I can’t wait to fly it.”

OSIRIS-Rex is scheduled to launch Sept. 8 at 7:05 p.m. EDT aboard an Atlas V rocket from Space Launch Complex 41 at Cape Canaveral Air Force Station, Florida. The Atlas V has proven a reliable option for NASA’s Launch Services Program, or LSP, the organization that oversees NASA launches and chooses the best launchers for different spacecraft. The mission has a 34-day launch window beginning Sept. 8.

As planned, the spacecraft will reach its near-Earth asteroid target, called Bennu (formerly 1999 RQ36), in 2018. Once within three miles of the asteroid, the spacecraft will begin six months of comprehensive surface mapping.

The science team then will pick a location where the spacecraft’s arm will take a sample. The spacecraft gradually will move closer to the site, and the arm will extend to collect at least a 2.1-ounce sample for return to Earth in 2023. The mission will help scientists investigate how planets formed and how life began, as well as improve our understanding of asteroids that could impact Earth.

Bennu is about 1,900 feet in diameter or roughly the size of six football fields. The asteroid, a little altered over time, is likely to represent a snapshot of our solar system’s infancy.

NASA’s Goddard Space Flight Center provides overall mission management, systems engineering, and safety and mission assurance for OSIRIS-REx. Lauretta is the principal investigator at the University of Arizona’s Lunar and Planetary Laboratory. Lockheed Martin Space Systems in Denver built the spacecraft. OSIRIS-REx is the third mission in NASA’s New Frontiers Program. NASA’s Marshall Space Flight Center in Huntsville, Alabama, manages New Frontiers for the agency’s Science Mission Directorate in Washington, D.C. Launch and countdown management is the responsibility of NASA’s John F. Kennedy Space Center.

Orion passes pressure test

Mars

Engineers: Weld points will protect astronauts during launch, in-space, re-entry, landing phases of Exploration Mission 1

BY LINDA HERRIDGE

Engineers at Kennedy Space Center recently conducted a series of pressure tests of the Orion pressure vessel. Orion is the NASA spacecraft that will send astronauts to deep space destinations, including on the journey to Mars. The tests confirmed that the weld points of the underlying structure will contain and protect astronauts during the launch, in-space, re-entry and landing phases on the Exploration Mission 1 (EM-1), when the spacecraft performs its first uncrewed test flight atop the Space Launch System rocket.

The Orion pressure vessel contains the atmosphere that a crew would breathe during a mission. It also will provide living and working space for the crew, and withstand the loads and forces experienced during launch and landing.

In late April, Orion was lifted by crane from its assembly and

tooling stand and moved to a test stand inside the proof pressure cell. The assembly and tooling stand is called the birdcage because it closely resembles a birdcage, but on a much larger scale.

To prepare for the test, technicians attached hundreds of strain gauges to the interior and exterior surfaces of the vehicle. The strain gauges were attached to provide real-time data to the analysts monitoring the changes during the pressurization. The analysts were located in the control room next to the pressure cell. The large doors were closed and sealed and Orion was pressurized to more pressure than it is expected to encounter on orbit.

Lockheed Martin, the manufacturer of the Orion crew module, ran the test at incremental steps over two days to reach the maximum pressure. During each step, the team pressurized the chamber and then evaluated the data to identify changes for the next test parameter. The results revealed the workmanship of the crew module pressure vessel welds and how the welds reacted to the stresses from the pressurization.

"We are very pleased with the performance of the spacecraft during proof pressure testing," said Scott Wilson, NASA manager of production operations for the Orion Program. "The successful completion of this test represents another major step forward in our march toward completing the EM-1 spacecraft, and ultimately, our



Lockheed Martin engineers and technicians prepare the Orion pressure vessel for a series of tests inside the proof pressure cell in the Neil Armstrong Operations and Checkout Building. Photo credit: NASA/Kim Shiflett

crewed missions to deep space."

"It gives the team a lot of pride to see Orion coming together for EM-1," said Ed Stanton, a systems engineer for Orion Production Operations in the Ground Systems Development and Operations Program.

Orion was tested inside the proof pressure cell in the high bay of the Neil Armstrong Operations and Checkout Building. After being

"It gives the team a lot of pride to see Orion coming together for EM-1."

—Ed Stanton
Systems Engineer for Orion Production Operations in the Ground Systems Development and Operations Program

moved back to the birdcage assembly stand, technicians will begin the intricate work of attaching hundreds of brackets to the vessel's exterior to hold the tubing for the vehicle's hydraulics and other systems.

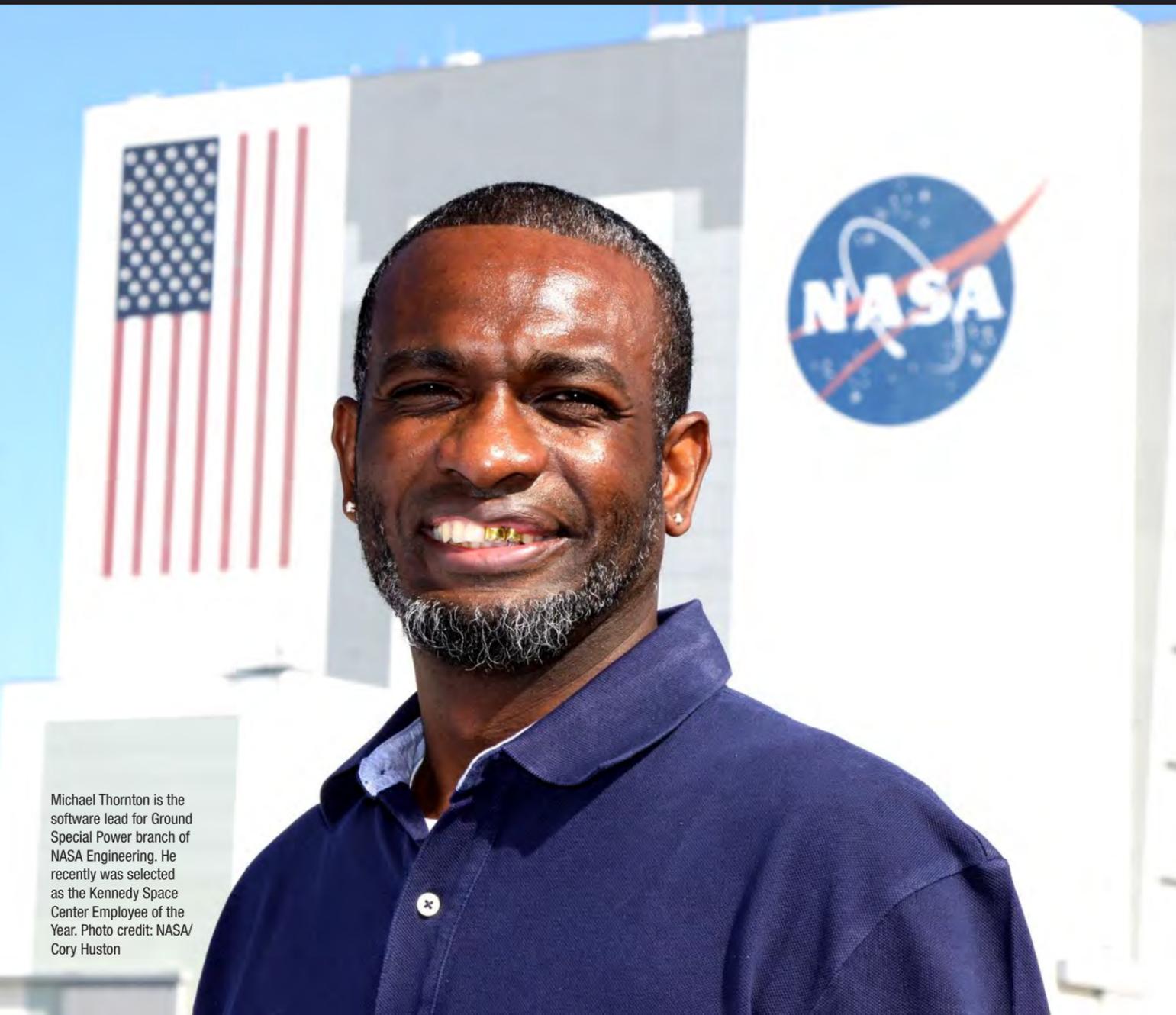
Future tests include a launch simulation and power on. Orion also will be sent to NASA Glenn Research Center's Plum Brook Station facility in Sandusky, Ohio, for acoustics and vibration tests. The uncrewed Orion will be outfitted with most of the systems needed for a crewed mission.

NASA's Space Launch System rocket with the Orion spacecraft atop will roar into space from Kennedy's Launch Pad 39B. EM-1 will send Orion on a path thousands of miles beyond the moon over a course of three weeks, farther into space than human spaceflight has ever travelled before. The spacecraft will return to Earth and safely splash down in the Pacific Ocean off the coast of California. This mission will advance and validate capabilities required for human exploration of Mars.

For more information about GSDO, visit: www.nasa.gov/groundsystems.

JOURNEY TO MARS
Join us on our #JourneytoMars

EMPLOYEE OF THE YEAR



Michael Thornton is the software lead for Ground Special Power branch of NASA Engineering. He recently was selected as the Kennedy Space Center Employee of the Year. Photo credit: NASA/Cory Huston

Thornton leads upgrade of Ground Special Power for Orion

BY BOB GRANATH

When Michael Thornton was growing up in the small south Florida city of Clewiston, he never dreamed of working in America's space program. Today, he not only is helping NASA prepare for the Journey to Mars, he recently was selected as Kennedy Space Center's Employee of the Year.

As the Ground Special Power software lead for the Power Systems Branch of NASA's Engineering Directorate at Kennedy, Thornton traveled to Denver in 2015 for a meeting between officials with NASA and Lockheed Martin, prime contractor for the Orion spacecraft. Following the review, he realized there was a need to upgrade ground power systems to adequately support the new vehicle.

According to Dean Petruzzello, chief of the Power Systems Branch at Kennedy, Thornton found that some of center's ground power interfaces were lacking the ability to take full advantage of several features included in Lockheed Martin's plans for Orion to receive electrical power during ground processing.

"He brought those issues to the attention of the Engineering Directorate's lead design engineer and management team," he said in nominating Thornton for special recognition. "Michael has also identified and presented solutions to the design team which were approved for correction and implementation."

For this achievement, Thornton was selected as NASA's Kennedy Engineering Employee of the Month for September 2015. From among last year's Employees of the Month, he was recently honored

further as the spaceport's 2015 Employee of the Year.

Thornton prefers to give credit to those he works with on a daily basis.

"I don't think I would be here without my team," he said. "They definitely work hard and we work together as one. We all listen and understand each other. That's what makes us jell as a team."

Having been raised in Clewiston, a city of just over 7,000 citizens, the Florida spaceport seemed to be far away. Thornton thought he had "no chance" of ever working in the Space Shuttle Program he heard and read about.

But in 1999 Thornton graduated from the University of Central Florida with a bachelor's degree in electrical engineering. A few months later, he had an opportunity to interview with and go to work for United Space Alliance, or USA, NASA's Space Program Operations Contractor at Kennedy.

"It was very exciting to actually get to work in the Shuttle Program," he said.

USA was formed as a limited liability company between Lockheed Martin and Boeing to operate the Shuttle Program at Kennedy, the Johnson Space Center in Houston and Marshall Space Flight Center in Huntsville, Alabama.

In 2005, Thornton was offered a new opportunity to go to work in NASA's Engineering Directorate. Today, he is leading a team that is preparing Ground Special Power, or GSP, to support the agency's Orion spacecraft.



Inside the Neil Armstrong Operations and Checkout Building high bay at Kennedy Space Center, the Orion crew module pressure vessel is undergoing testing and assembly leading to Exploration Mission 1 in 2018. EM-1 will be an uncrewed flight test in which the spacecraft will launch atop NASA's Space Launch System rocket. Photo credit: NASA/Bill White



This artist concept of the Space Launch System, or SLS, depicts stacking in the Vehicle Assembly Building, or VAB, at Kennedy Space Center. Michael Thornton noted that electrical support will be needed anyplace the vehicle needs power including key locations including the VAB where it will be stacked atop the SLS rocket. Image credit: NASA/ Marshal Space Flight Center

Built to take humans farther than they have ever gone before, Orion will be the exploration vehicle that will carry crews to space launched atop NASA's new Space Launch System rocket, the largest and most powerful ever flown. The SLS rocket will be capable of sending humans aboard Orion to deep-space destinations such as an asteroid and Mars.

During the times Orion spacecraft are assembled and processed at Kennedy, Thornton's group acts as the "power company."

"Anytime Orion needs electricity, we make sure the spacecraft gets what it needs," he said. "We convert AC power to DC through the ground power unit."

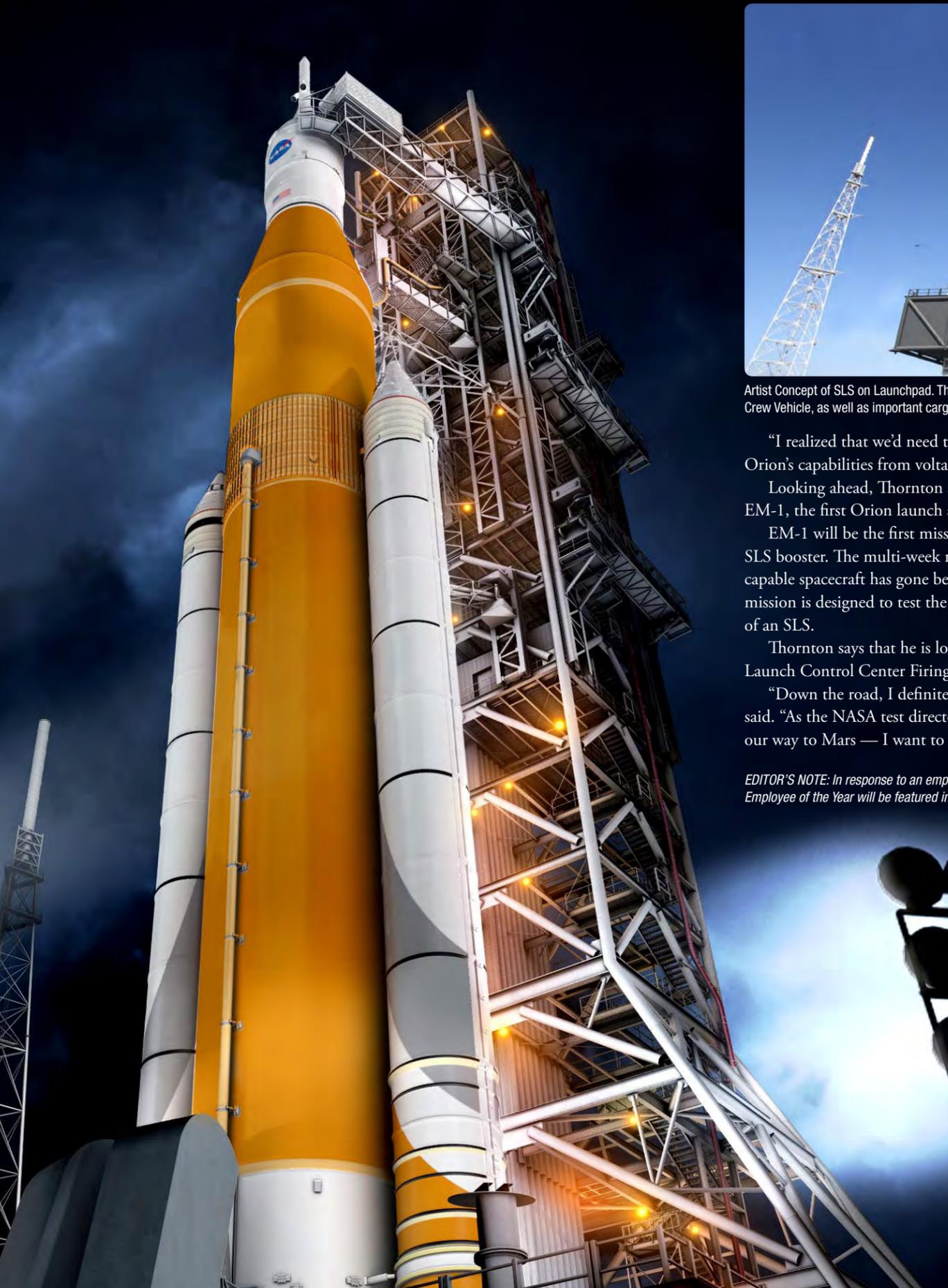
AC, or alternating current, is an electric stream in which the flow of electric charge periodically reverses direction, whereas in DC, direct current, the flow of electric charge is only in one direction.

Thornton noted that electrical support would be needed anyplace the vehicle needs power, including the Multiple Payload Processing Facility where Orion will undergo testing. As processing moves along, other key locations will include the Vehicle Assembly Building where it will be stacked atop the SLS rocket, and Launch Pad 39B right up until the final moments before liftoff.

Recently, Thornton and his team have been designing and developing the integrated launch operations applications software for the electrical power distribution and control, or EPD&C, systems. This effort has included the fabrication, installation and verification of GSP hardware racks, which include power supply, backup battery modules and interface control displays.

"Michael has provided invaluable leadership during the development of the software requirements documents, programmable logic controller code, displays and models," Petruzzello said. "His knowledge of the EPD&C and GSP systems continues to be a driving force to the team."

During his recent visit to Lockheed Martin in Denver, Thornton learned about many of the Orion capabilities that will require GPU support.



Artist Concept of SLS on Launchpad. The Space Launch System, or SLS, will be designed to carry the Orion Multi-Purpose Crew Vehicle, as well as important cargo, equipment and science experiments. Image Credit: NASA/MSFC

"I realized that we'd need to modify the center's GPU systems to take full advantage of Orion's capabilities from voltage monitors to the spacecraft's avionics," he said.

Looking ahead, Thornton and his team already are planning for Exploration Mission 1, or EM-1, the first Orion launch atop an SLS rocket slated for late 2018.

EM-1 will be the first mission in which the Orion spacecraft will be integrated with the large SLS booster. The multi-week mission will send the spacecraft farther into space than any human-capable spacecraft has gone before. Flying nearly 40,000 miles beyond the orbit of the moon, the mission is designed to test the vehicle, making sure it's safe to put humans aboard the next launch of an SLS.

Thornton says that he is looking forward to that first SLS liftoff and hopes to be in the Launch Control Center Firing Room.

"Down the road, I definitely would like to be in the Firing Room with my headset on," he said. "As the NASA test director is polling his people on that first EM-1 mission — a big step on our way to Mars — I want to be the person to say, 'yes, we are go.'"

EDITOR'S NOTE: In response to an employee suggestion, individuals honored in the future as NASA's Kennedy Space Center Employee of the Year will be featured in upcoming articles.

PREVIOUS NASA KENNEDY SPACE CENTER EMPLOYEES OF THE YEAR ARE:

- 2010 — Pamela Zeitler
- 2011 — Michelle Green
- 2012 — David Ungar
- 2013 — Jennifer Van den Driessche
- 2014 — John Speck
- 2015 — Michael Thornton

JOURNEY TO MARS
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This artist concept of the NASA's Space Launch System, or SLS, shows it as it is in preparation for flight at the Kennedy Space Center's Launch Pad 39B. Michael Thornton's Ground Special Power Branch of NASA Engineering will provide power to the Orion spacecraft in all areas where processing will take place. The first vehicle designed to meet the challenges of launching Orion on the Journey to Mars, SLS will be the most powerful rocket ever built. Image credit: NASA/ Marshal Space Flight Center

POWER TO THE PLATFORM

Tests simulate how platforms will surround Space Launch System on mobile launcher

BY LINDA HERRIDGE

“As each half of the J platforms slowly extended, I couldn’t help but think forward to the day when the SLS core stage and boosters will fill the void between the platform halves.”

—Mike Bolger
GSDO Program Manager

For the first time, one of the new work platforms in High Bay 3 inside the Vehicle Assembly Building at Kennedy Space Center was powered on. Lights illuminate one half of the J-level platforms for NASA’s Space Launch System on April 28 as the platform is extended. A preliminary test of both J platforms was completed to verify each platform’s motor, roller system and electrical connections. Photo credit: NASA/Kim Shiflett

Kennedy Space Center is one power step closer to processing the agency’s Space Launch System (SLS), the most powerful rocket in the world, for its first flight, Exploration Mission 1 (EM-1), and NASA’s journey to Mars. During a preliminary test April 28, the two J-level work platforms installed on the north and south sides of Vehicle Assembly Building High Bay 3, where the SLS will be prepared for launch, were successfully activated to test their functionality and simulate how they will surround the massive rocket on the mobile launcher.

Mike Bolger, Ground Systems Development and Operations Program (GSDO) manager, stood on the walkway on the 16th floor, above the J-level platforms, as construction contractor Hensel Phelps operated the controls and began the test.

“It was an amazing sight to look down and watch as the platform smoothly extended out into the open air of High Bay 3,” Bolger said. “As each half of the J platforms slowly extended, I couldn’t help but think forward to the day when the SLS core stage and boosters will fill the void between the platform halves.”

The J-level work platforms are just one of 10 levels of platforms that will surround the SLS rocket and Orion spacecraft in the high bay. The platforms will extend and retract and will have the capability to be adjusted up or down as required to give engineers and technicians access to various areas of the giant rocket, twin solid rocket boosters, Orion and its launch abort system during processing and testing.

Each of the platform halves are about 62 feet wide and 38 feet long and weigh between 300,000 and 325,000 pounds. The J-level platforms are located about 112 feet above the VAB floor, or nearly 11 stories high, and will provide access to the SLS booster.

For this first test, initial power-up and platform extension took about 30 minutes. When the system is fully operational it will take less time, according to Jose Perez Morales, GSDO VAB Element senior project manager.

“The success of this test is another step in the realization of years of design and construction to prepare High Bay 3 for the Space Launch System rocket,” said Morales.

Two independent motors and chains, called drive chain rail activators, are located on the rails on either side of the platform. They were tested, along with the motors and tracks, to confirm they functioned properly. As each platform extended, it glided on four rollers positioned with two on each side of the platform — much like a kitchen drawer glides in and out. The movement of the mechanical articulated tray that moves with the platform also was tested.

“To the GSDO team, this is another positive indicator that we’re making progress and that we’re going to be ready when the flight hardware arrives for integration, test and launch from Kennedy Space Center,” Bolger said.

“We just accomplished a significant milestone for this project, and we are looking forward to the next ones,” said Gary Villa, NASA construction manager.

As additional platforms are installed in High Bay 3, they will undergo the same testing to ensure all of the platforms are ready for the first launch.

To watch the first new work platforms for NASA’s Space Launch System get powered on and tested, go to <http://go.nasa.gov/1X0T1o8>.

JOURNEY TO MARS
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KENNEDY SPACE CENTER
Exploration Begins Here



Ed Stanton
Systems Engineer for Orion Production Operations
Ground Systems Development & Operations Program

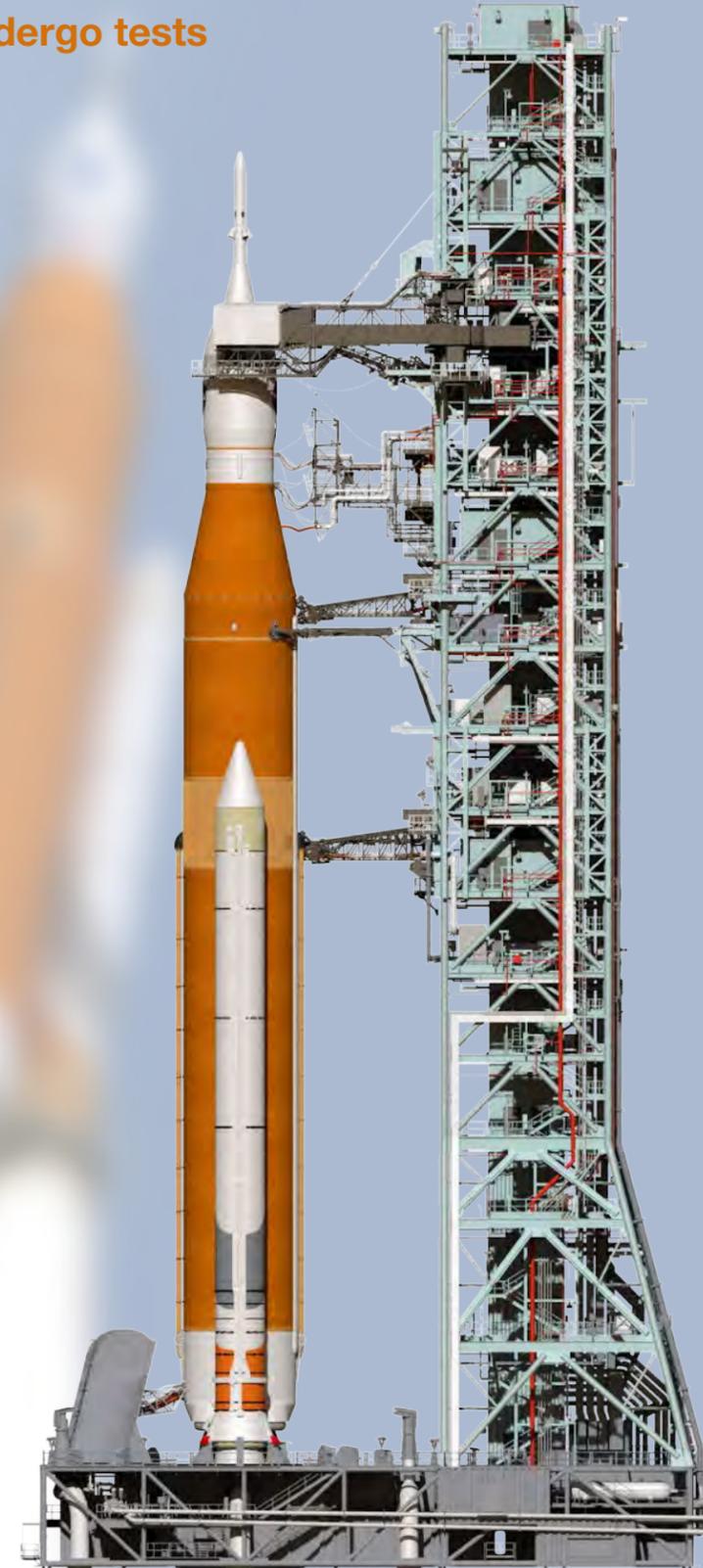
CHECKING THE LINES

Mobile launcher tower umbilicals undergo tests

NASA's Space Launch System rocket, or SLS, will be the most powerful rocket in the world, and will have the capability to launch humans beyond Earth's orbit. The SLS rocket, powered by four RS-25 core stage engines and two solid rocket boosters, along with an RL-10 in-space propulsion engine, will provide the energy necessary to launch the Orion spacecraft on to deep-space destinations, including the journey to Mars.

Prior to rollout for launch, the Orion spacecraft will be stacked atop the SLS rocket and processed on the mobile launcher inside the Vehicle Assembly Building High Bay 3 at NASA's Kennedy Space Center in Florida. The tower on the mobile launcher will be equipped with several connections, called launch umbilicals, which will connect to the SLS's core stage and twin solid rocket boosters as well as the interim cryogenic propulsion stage (ICPS) and the Orion spacecraft. These umbilicals will provide power, communications, coolant, and fuel. Additional accessories will provide access and stabilization to the rocket and spacecraft.

The launch umbilicals and accessories are being tested at Kennedy's Launch Equipment Test Facility by the center's Engineering Directorate and NASA's Ground Systems Development and Operations Program. The tests will ensure each launch accessory is functioning properly and is ready for installation on the mobile launcher tower. During launch, each accessory will release from its connection point, allowing the rocket and spacecraft to lift off safely from the launch pad.



7th Annual

National Aeronautics and Space Administration

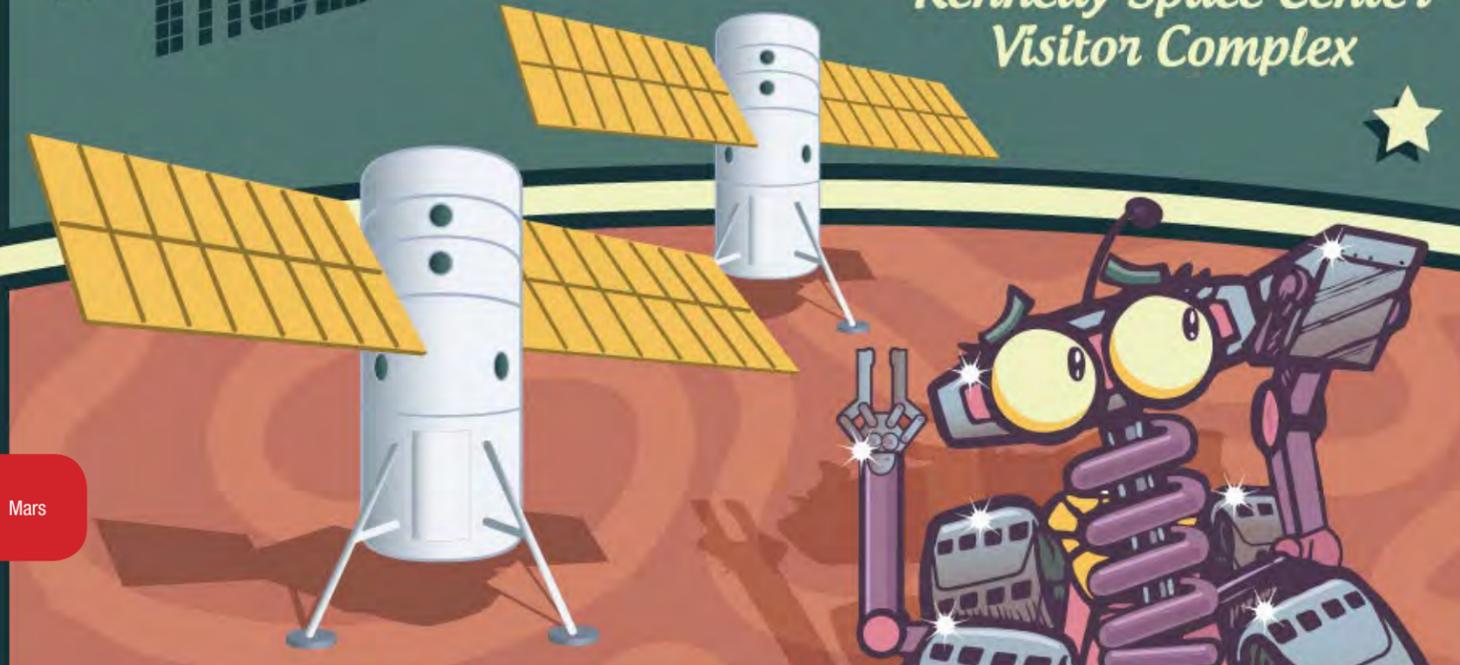


NASA ROBOTIC MINING COMPETITION

MAY 16-20, 2016

Kennedy Space Center Visitor Complex

Mars



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SP-2016-03-002-KSC

Crowdsourcing Robots

College students help NASA on its journey to Mars

BY AMANDA GRIFFIN

When explorers first set out to discover new lands, they couldn't take everything they needed with them. They packed what they could and then lived off the land once they arrived, using trees for building materials, making bricks out of clay, securing water and food from the earth. It will be no different when humans explore deeper into our solar system, using in-situ resource utilization, or ISRU — where an abundance of resources, such as water, reside in greater amounts in space than here on our home planet. The water

The competition, which takes place May 16-20 at the Kennedy Space Center Visitor Complex in Florida, focuses on technologies necessary to extract consumables such as oxygen and water to support human life and provide methane fuel to spacecraft. The technologies also can be used to mine source materials on-site for landing pads, buildings and even radiation shields — saving an estimated \$40,000 per kilogram in transportation costs alone from the Earth's surface to low-Earth orbit.



Participants in NASA's 7th annual Robotic Mining Competition refine their robotic excavator before taking it to the competition arena for competitive runs. Photo credit: NASA/Bill White

is frozen or chemically bound to the regolith, and excavation is a crucial step in acquiring the water necessary to survive and travel in space.

The 7th Annual NASA Robotic Mining Competition (RMC) is set up for college students to design and build a mining robot that can travel over a simulated Martian surface, excavate regolith — or Mars dirt — and deposit as much of it as possible into a bin, all within 10 minutes. Team members may control their bots remotely from a trailer where their only line of sight is via a computer screen, or completely autonomously, with their programming skills put to the test as their robot handles the mission on its own. Essentially, NASA is crowdsourcing ideas from inventive college students who want to be part of NASA's journey to Mars.

Rob Mueller, a senior technologist in the NASA Kennedy Space Center Swamp Works and head judge and co-founder of the Robotic Mining Competition, knows the value of crowdsourcing ideas. "While it takes about one year to fully develop a mining robot in a research lab, RMC showcases 50 Martian mining prototypes in just one week," said Mueller.

The scoring for the mining category will require teams to consider a number of design and operation factors such as dust tolerance and projection, communications, vehicle mass, power needs and autonomy. Teams also have to keep in mind the fine and abrasive characteristics of the regolith, and the weight and size limitations of the mining robot. While the team with the most points from all categories will win a cash prize, the real reward is



Participants in NASA's 7th annual Robotic Mining Competition watch as their robotic excavator starts inside a protected bin of simulated regolith at the start of the competition. Photo credit: NASA/Bill White

Opposite: Participants in NASA's 7th annual Robotic Mining Competition tote their robotic excavators to the competition arena on the first day of competitive runs following morning practice rounds. Photo credit: NASA/Bill White

helping NASA solve an engineering problem and gaining critical systems engineering and robotics skills that are highly sought by employers.

NASA directly benefits from RMC by seeing firsthand clever ideas and solutions that could be applied to an actual excavation device or payload — projects Swamp Works is working on today. The unique physical properties of basaltic regolith on Mars and the reduced, one-third gravity make excavation a difficult technical challenge. One critical resource on Mars is water ice, which can be found buried in the regolith where it is well insulated. During RMC, teams will have to dig for gravel under the soil surface that simulate this ice.

Advances in Martian mining, including those displayed every

year during the competition, have the potential to significantly contribute to our nation's space exploration endeavors. Recent data from NASA Mars missions indicate a global presence of at least 5 percent water in the Martian soil. In order to obtain this water for use as life support and propellants, it must be mined and processed. Time delays in communications to Mars mean that using autonomous regolith mining robots to acquire the water resources may work better. All of these challenges are simulated in the competition.

Throughout the years, engineers at Swamp Works have used what they have seen during the competition to improve their Regolith Advanced Surface Systems Operations Robot, or RASSOR.

“Many teams have problems with mobility on the loose regolith,



“This competition trains the students using NASA systems engineering methods, which puts them in a great position to find a good job — and, of course, NASA would like to hire a few of them as well!”

—Rob Mueller
Senior Technologist at Kennedy Space Center's Swamp Works
and Head Judge and Co-founder of the Robotic Mining Competition



A robotic excavator stands in an assembly area ahead of NASA's 7th annual Robotic Mining Competition. Photo credit: NASA/Bill White

so tracks versus wheels has been a big design consideration for us," said Drew Smith, NASA lead design engineer for RASSOR. "By watching the various wheel and track designs perform, we have been able to determine that, in general, larger diameter and wider wheels are more reliable — and that has been a factor in selecting wheels for our latest prototype, RASSOR 2.0."

As we embark on deep-space missions with weeks- or months-long travel times, ISRU becomes increasingly important because resupply missions are expensive and exclusively relying on them may put crews at risk.

"Mission capabilities and return on investment multiply when human consumables and spacecraft propellant can be harvested from extraterrestrial environments," said Mueller. "For example, 1 kilogram on the Mars surface requires 11 kilograms to be launched into low-Earth orbit. By making propellants and consumables on Mars, we can

avoid this large mass multiplier."

Mueller and his team have calculated that three RASSORs could mine regolith to produce enough propellant (30 tons) to launch astronauts back into Mars orbit for the journey home on the Mars Ascent Vehicle, as well as produce water and oxygen for life support and growing plants.

"Autonomous robots are becoming more common across industry on Earth and in space; tomorrow's workforce are the students that graduate today," Mueller said. "This competition trains the students using NASA systems engineering methods, which puts them in a great position to find a good job — and, of course, NASA would like to hire a few of them as well!" said Mueller.

Since its inception, RMC has hosted more than 400 different robots and more than 3,000 students from across the United States, including Alaska, Hawaii and the Commonwealth of Puerto Rico.

ROLL TIDE

Alabama team takes top robotic honors

BY STEVEN SICELOFF

Students from the University of Alabama, Tuscaloosa, earned the top award at this year's Robotics Mining Competition.

Although the teams get to decide whether to give their robots direction by remote control or program them to work autonomously, the machines are tasked with collecting as much regolith as they can and then depositing it into a container, and all with a simulated communications lag akin to the one real robots on Mars face.

The participants are pushing for trophies, to be sure, but the experience is a one-of-a-kind benefit to those who take part in the competition, they said.

"You get a feel for what industry is like," said Joe Kabalin of the Alabama Astrobotics team. "You get to talk to people all over the country, all different disciplines and then you get to come here and meet other teams that have solved the same problem, but in a completely different way. Seeing how people think and solve a problem is a very valuable experience."

Participants across the board said persistence is the top skill for any squad to bring to the competition because the machinery, software and simply handling the unusual soil make smooth operations very rare.

"Our first practice round showed us a few problem areas but we fixed those overnight," said Will Leishman, a sophomore from Montana Tech in Butte who was part of the school's 15-member squad.

While some teams comprise two dozen members or more, there are also small groups at the competition, such as the team of three from John Brown University in Siloam Springs, Arkansas. Their motto: Three engineers, three robots.

"I enjoy the chance to go out and do something new and novel," said Matthew Stoering of John Brown University. "For us, we're working with a technology that is two years old, so if you google it you don't get anything. We get to develop really new and innovative solutions."

This year's participants said they want their success to be a beacon to younger students who are now in high school and middle school and are just considering the career path they might take as they move toward college.

"It's definitely a journey, but you can see that it's doable and you have to stick with it," said Sean Donovan of Milwaukee School of Engineering in Wisconsin.

AND THE WINNERS ARE...

JOE KOSMO AWARD FOR EXCELLENCE
– The University of Alabama

ON-SITE MINING AWARD
– 1st - Alabama Astrobotics from The University of Alabama
– 2nd - Moon Pi from Embry-Riddle Aeronautical University
– 3rd - Oakton Robotics from Oakton Community College

SLIDE PRESENTATION AND DEMONSTRATION AWARD
– 1st - The University of Alabama
– 2nd - University of North Dakota
– 3rd - Colorado School of Mines

SOCIAL MEDIA AND PUBLIC ENGAGEMENT AWARD
– 1st - Iowa State University
– 2nd - Oakton Community College
– 3rd - The University of Alabama

OUTREACH PROJECT AWARD
– 1st - University of North Dakota
– 2nd - Iowa State University
– 3rd - Oakton Community College

SYSTEMS ENGINEERING PAPER AWARD
– 1st - The University of Illinois Urbana-Champaign
– 2nd - Oakton Community College
– 3rd - The University of Illinois at Chicago

COMMUNICATION AWARD
– The University of Akron

CATERPILLAR AUTONOMY AWARD
– 1st - The University of Alabama
– 2nd - South Dakota School of Mines

SSERVI REGOLITH MECHANICS INNOVATION AWARD
– Embry-Riddle Aeronautics University

INNOVATION AWARD
– The University of Utah

Watch how NASA's 7th annual Robotic Mining Competition puts student engineers to the test at <http://go.nasa.gov/1U8Lf6u>

REVVED-UP MODS

Upgrades to Launch Pad 39B flame trench will support Space Launch System rocket

BY LINDA HERRIDGE

Mars

Construction workers with J.P. Donovan of Rockledge, Florida, prepare the concrete walls for new heat-resistant bricks in the Launch Pad 39B north flame trench at Kennedy Space Center on April 14. Photo credit: NASA/Kim Shiflett

NASA's Space Launch System (SLS) rocket and Orion spacecraft will roar into deep space from Launch Pad 39B at Kennedy Space Center. Before the most powerful rocket in the world takes flight, the Ground Systems Development and Operations (GSDO) Program continues making significant upgrades and modifications to the historic pad to accommodate the new rocket's shape and size. Exploration Mission 1 (EM-1) will be the first of many missions of SLS and Orion as the agency prepares for its journey to Mars.

In June 2015, NASA awarded a contract to J.P. Donovan Construction of Rockledge, Florida, to upgrade the flame trench and provide a new flame deflector. This system is critical to safely containing the plume exhaust from the massive rocket during launch. Construction workers have been busy, removing old adhesive material and preparing the walls for brick installation on the north side of the trench.

"It's very exciting to see this project making such great progress. The flame trench and flame deflector are the last large pieces of the puzzle required at the pad prior to integrating testing with the

mobile launcher and before launch," said Regina Spellman, GSDO launch pad senior project manager.

The north side of the flame trench is about 571 feet long, 58 feet wide and 42 feet high. The new flame deflector will divert the rocket's exhaust, pressure and heat to the north. To determine where the most pressure and heat will occur during launch, a team of engineers from Kennedy and NASA's Ames Research Center in Moffett Field, California, used computational fluid dynamics to locate the areas of significant temperature and pressure. In these areas of concern, adhesive anchors are being drilled into the walls at intervals to hold the metal plates that will reinforce the brick system before the mortar and bricks are added.

Construction workers now are preparing the north side of the flame trench to withstand temperatures of up to 2,000 degrees Fahrenheit at launch of the rocket's engines and solid rocket boosters. About 100,000 heat-resistant bricks, in three different sizes, will be secured to the walls using bonding mortar in combination with the adhesive anchors.

"The contractor is performing quality checks as the work progresses," said Lori Jones, an engineer and project manager for Construction of Facilities for the pad flame trench and deflector.

Because all of the rocket's flame and energy at liftoff will be diverted to the north side of the flame trench, the south side of the flame trench will not be covered in brick, but instead, will be repaired and remain a concrete surface.

The new flame deflector will be positioned about six feet south of the old flame deflector's position. The north side of the deflector will be protected by a NASA standard coating. The south side of the deflector will not be slanted and will have no lining. The new design will provide easier access for inspection, maintenance and repair.

The two side flame deflectors, repurposed from space shuttle launches, will be refurbished and reinstalled at pad level on either side of the flame trench to help reduce damage to the pad and SLS rocket.

To accommodate the new configuration, an access door between the west catacomb and the main deflector was moved to a new

"The flame trench has withstood so many historical launches, and we are giving it new life to withstand many more."

—Regina Spellman
GSDO Launch Pad
Senior Project Manager

location. A new opening was cut into the east side of the flame trench wall to relocate the ignition over pressure/sound suppression system's water pipes that will feed the deflector's crest spray system.

The flame trench modifications currently are scheduled to be completed by March 2017. Additional work will begin soon to reinforce the catacomb below the pad surface so it can handle the load of the SLS rocket.

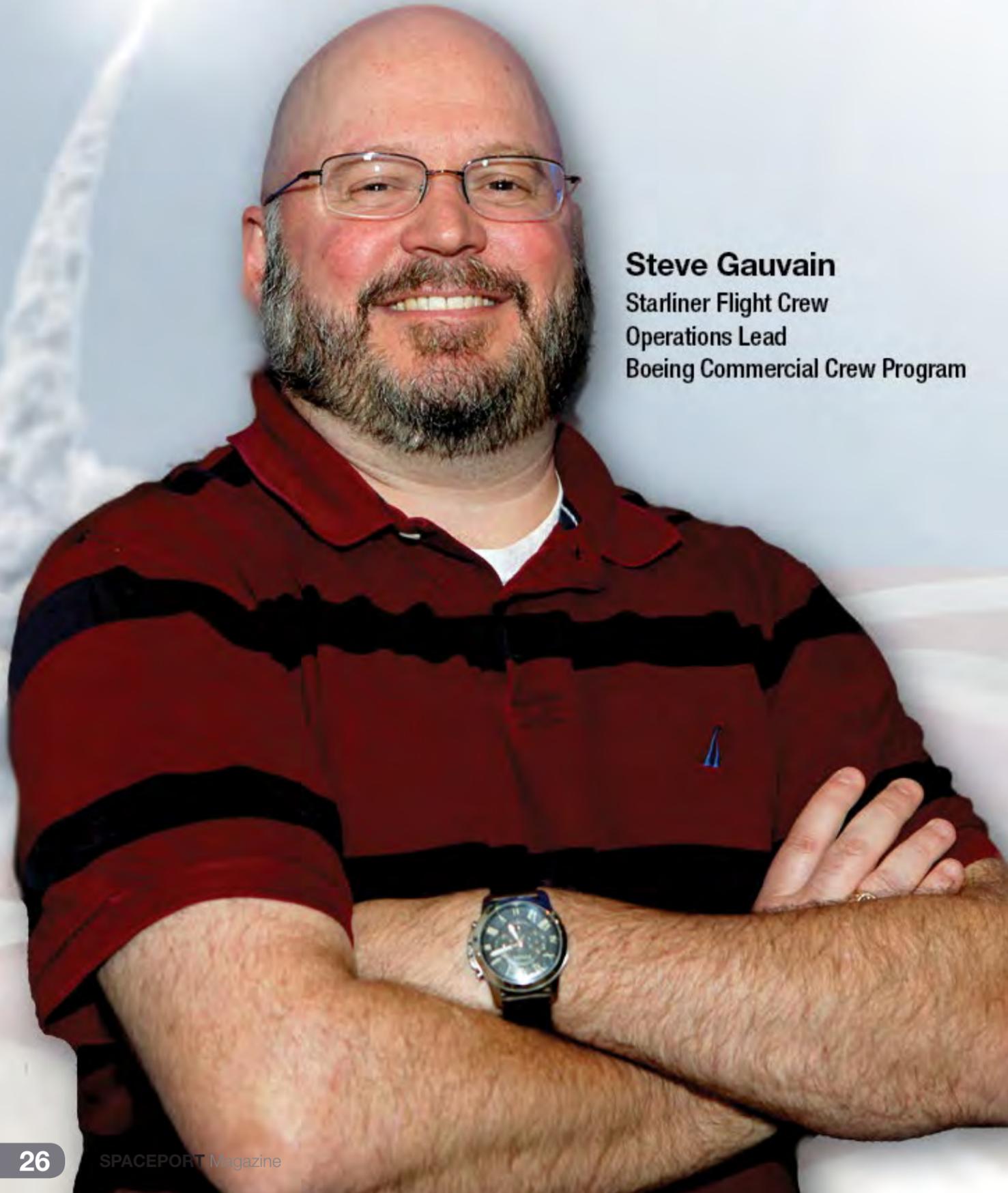
A previously completed project included removal of all of the crawler track panels on the pad's surface, repair of the surface beneath the panels and the catacomb roof below, and reinstallation of existing panels or, depending on their condition, installation of some new track panels.

"The flame trench has withstood so many historical launches, and we are giving it new life to withstand many more." Spellman said.

To watch progress being made on the Launch Pad 39B north flame trench at Kennedy Space Center, go to <http://go.nasa.gov/1OnyYcl>

I Will LAUNCH AMERICA

Restoring America's Human Launch Capability



Steve Gauvain
Starliner Flight Crew
Operations Lead
Boeing Commercial Crew Program

I Will Launch America: Starliner Flight Crew Operations Lead Steve Gauvain

Engineer employs art, science to design cockpits for new generation spacecraft

BY STEVEN SICELOFF

Astronauts heading into orbit aboard a new generation of commercially developed spacecraft will read instruments on a tablet and count on only a few physical buttons and joysticks to fly to and rendezvous with the International Space Station.

These high-tech systems will not have rigid panels that stretch over several positions and house row-upon-row of switches, dials and readouts like those on the Apollo spacecraft and space shuttle.

About four years ago, a small team at Boeing, including Steve Gauvain, flight crew operations lead for the company's CST-100 Starliner, started designing the control panel and crew interface to ensure that crew members would have the data they need.

Designing the control network and systems is the province of a team of engineers, and draws upon the expertise of Boeing teams from different specialties to make all the instruments work together.

"The thing that makes my job really fun is that there is a team that is really smart about the life support system, there is a team that is really smart about the electrical system," Gauvain said.

"I've got a colleague who lives for relative navigation. I get to go and talk to these people every day. Then the science turns into an art form to take all that engineering data and make it greater than the sum of its parts. I'm an engineer with a little bit of an artistic side. In order to make a good display and something intuitive for people to use, you have to combine the science and art."

The Starliner has about 30 displays crew members can navigate like a smart phone. The spacecraft has some switches, too, located in a wraparound console that the crew could access to perform critical tasks in the unlikely event of a computer or display problem.

Gauvain spent 15 years as a simulator engineer teaching astronauts the ins-and-outs of the space shuttle flight deck and how to handle emergency scenarios. Working on shuttle simulation scenarios gave Gauvain insight into what to offer Starliner crews so they know what is happening on their spacecraft quickly and can take action if necessary.

"Being able to observe that human behavior over a number of years showed me how astronauts break down situations and reassemble them in their head, and I tried to apply all those lessons learned to the Starliner cockpit," Gauvain said.

Starliner crew interface designers also included two conventional joysticks.

"From a pilot's perspective, we have two heritage hand controllers," Gauvain said. "One is like a traditional airplane stick, to pitch and yaw and roll, and then we have a translational hand controller, because, unlike an airplane which only goes forward, when you come up to dock with the International Space Station, you need to be able to go forward or backward or side to side."

The spacecraft is designed to fly itself through all phases of a mission, so unless an unexpected anomaly occurs, the astronauts won't use the controllers.

"One of the nice things about the Starliner is that we have an automated vehicle, so for the most part, the automated flight computers will take control and ferry the crew from the ground to the station with minimal interaction," Gauvain said.

"But there's always the possibility for something to go wrong, so we want to make sure that the crew is aware and understands what the vehicle is doing at all times. That way, at any time they deem necessary, they can jump in and either correct a problem or perform a reconfiguration as they see fit."

In September 2014, NASA awarded Boeing and SpaceX contracts to transport astronauts to and from the orbiting laboratory on American-made human spaceflight systems. While Boeing produces the Starliner to launch atop a United Launch Alliance Atlas V rocket, SpaceX is working on its Crew Dragon spacecraft and Falcon 9 rocket.

These commercially developed and maintained systems may open up low-Earth orbit flights to more people than ever before, eventually including tourists and scientists. Engineers had to keep various business models and scenarios in mind when designing their systems.

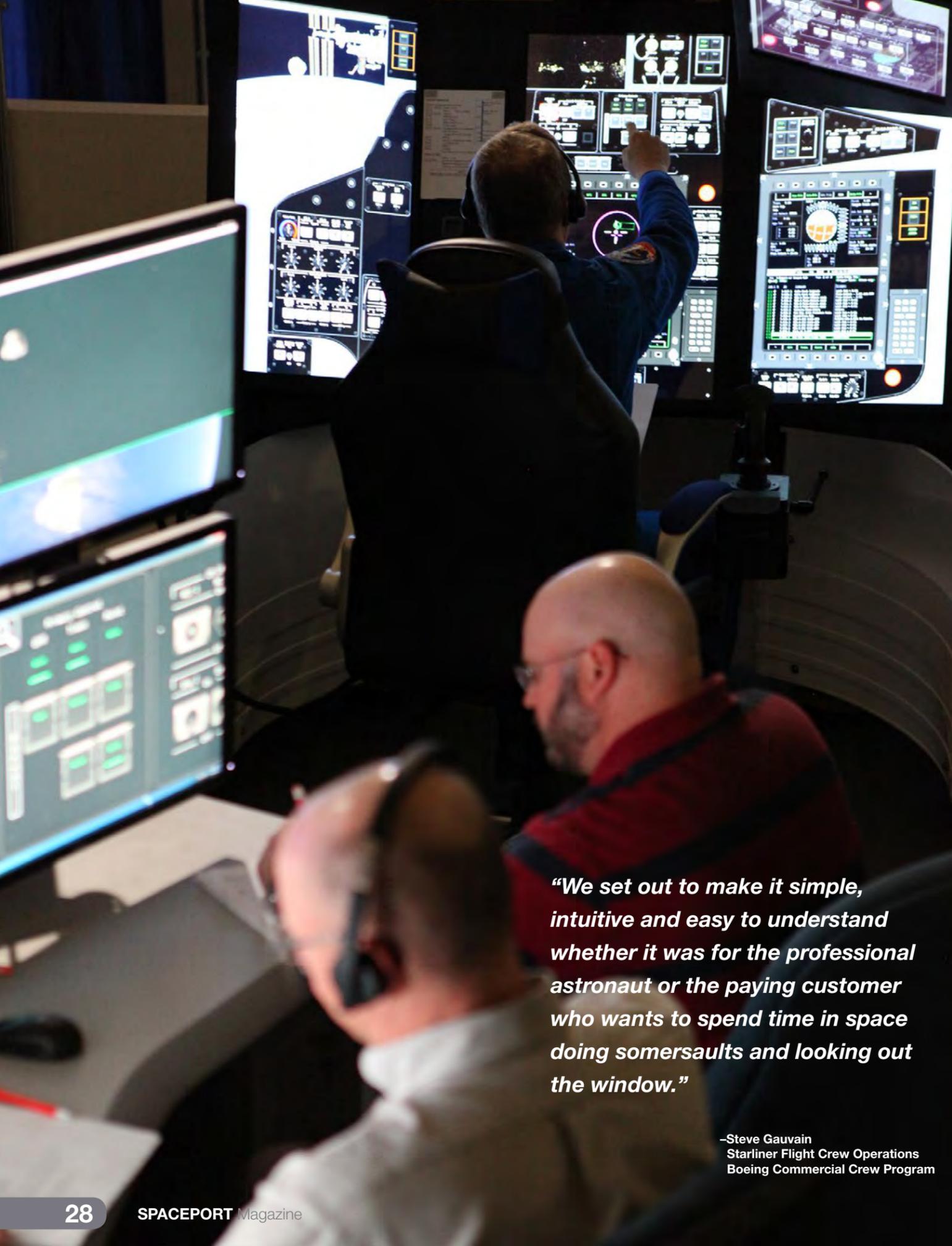
"We set out to make it simple, intuitive and easy to understand whether it was for the professional astronaut or the paying customer who wants to spend time in space doing somersaults and looking out the window," Gauvain said.

Gauvain's team was not limited to modeling a new cockpit; it also had to determine all the potential troubles a vehicle could have leading up to launch and during a mission.

"We took the base knowledge of 30 years operating the space shuttle and broke it down to understand how it could affect our spacecraft and how it could affect the space station," Gauvain said. "There was a lot of analysis. Over the course of maybe a year-and-a-half we sat down with all those super smart people, and we formulated a set of responses that was the safest thing to do for the station and the crew."

The Starliner is progressing through final development and manufacturing, while the NASA commercial crew astronauts practice mission phases with simulators.

"I can't wait for someone to fly our system on a real flight and then come back and tell me what I can make better next time," Gauvain said. "There definitely will be challenges, but it's about rising to the challenge and beating the problem and get to flying, because that's the goal."



“We set out to make it simple, intuitive and easy to understand whether it was for the professional astronaut or the paying customer who wants to spend time in space doing somersaults and looking out the window.”

—Steve Gauvain
Starliner Flight Crew Operations
Boeing Commercial Crew Program

Public Domain

NASA TECHNOLOGIES

We're opening up a selection of our patents as a gift to the public, making them free for anyone to use.



NASA makes dozens of patents available to benefit U.S. Industry

NASA has released 56 formerly-patented agency technologies into the public domain, making its government-developed technologies freely available for unrestricted commercial use. In addition to the release of these technologies, a searchable database now is available that catalogs thousands of expired NASA patents already in the public domain.

These technologies were developed to advance NASA missions but may have non-aerospace applications and be used by commercial space ventures and other companies free of charge, eliminating the time, expense and paperwork often associated with licensing intellectual property. The technologies include advanced manufacturing processes, sensors, propulsion methods, rocket nozzles, thrusters, aircraft wing designs and improved rocket safety and performance concepts. “By making these technologies available in the public domain, we are helping foster a new era of entrepreneurship that will again place America at the forefront of high-tech manufacturing and economic competitiveness,” said Daniel Lockney, NASA’s Technology Transfer program executive. “By releasing this collection into the public domain, we are encouraging entrepreneurs to explore new ways to commercialize NASA technologies.”

This patents release is the latest in NASA’s long tradition of extending the benefits of its research and development into the public sector, where it may enhance the economy and quality of life for more Americans. The release also may help familiarize commercial space companies with NASA capabilities and result in new collaborations with private industry.

The innovations included in this transfer were selected by NASA officials using a rigorous review process, during which decision-makers looked for technologies that offer the potential for high unit values but are less likely to be licensed by outside companies because of low demand for resulting products (e.g. spacecraft), or the technology still requires significant development before it is marketable.

A FEW EXAMPLES INCLUDE:

- Technologies designed to mitigate the dangerous gases created as humans live and work in space
- Inventions related to rocket nozzles, injection systems and propellants that might help launch a new generation of commercial spacecraft
- Methods for controlling airflow around vehicles in hypersonic flight

NASA’s patent portfolio, managed by the agency’s Technology Transfer Program, includes more than 1,000 technologies in categories such as manufacturing, optics and sensors, and is available for industry use through licensing agreements.

BOLTED DOWN

Starliner test article joined to complete first hull

BY STEVEN SICELOFF

The first CST-100 Starliner hull stands in one piece inside Boeing's Commercial Crew and Cargo Processing Facility at Kennedy Space Center after engineers bolted together the upper and lower domes May 2 as completion nears of the Structural Test Article. It is the first spacecraft to come together inside the former shuttle hangar since shuttle Discovery was moved out of the facility following its retirement and move to the Smithsonian's Udvar-Hazy Center near Washington, D.C., in 2012. You can watch Boeing's video about the spacecraft's manufacturing here.

Identical to the operational Starliners Boeing plans to build and fly in partnership with NASA's Commercial Crew Program, the Structural Test Article is not meant to ever fly in space but rather to prove the manufacturing methods and overall ability of the spacecraft to handle the demands of spaceflight carrying astronauts to the International Space Station.

STAJoin2Boeing is one of two contractors chosen by NASA to take astronauts to the station using American vehicles launching from U.S. soil. Tests with and without crew members will take flight before operational missions begin. The end result for NASA will be a larger space station resident crew and a doubling of scientific research time aboard the orbiting laboratory as scientists try to decipher the challenges of deep space exploration and provide enhancements for everyone on Earth.

The Starliner structural test article will go through final outfitting before it is moved to Huntington Beach, California, where it will be subjected to loads and separation testing. From there, the company expects to apply those lessons to the first flight test models of the Starliner, parts of which are already in the manufacturing flow in Florida.

"Our team is initiating qualification testing on dozens of components and preparing to assemble flight hardware," said John Mulholland, vice president and program manager of Boeing's Commercial Programs. "These are the first steps in an incredibly exciting, important and challenging year."

The building techniques used for Starliners are significantly different from those of past programs, Boeing said, and reflect a desire to ease manufacturing wherever possible. For instance, rather than



An engineer guides the upper dome of a Boeing CST-100 Starliner as it is connected to the lower dome to complete the first hull of the Starliner's Structural Test Article, a prototype spacecraft that is identical to the operational versions but not meant to fly in space. The work was performed inside the Commercial Crew and Cargo Processing Facility at Kennedy Space Center. The STA is built to endure harsh tests mimicking conditions of spaceflight to prove the design and its manufacturing techniques will work for space-bound Starliners. Photo credit: Boeing

"These are the first steps in an incredibly exciting, important and challenging year."

— John Mulholland Vice President and Program Manager of Boeing's Commercial Programs

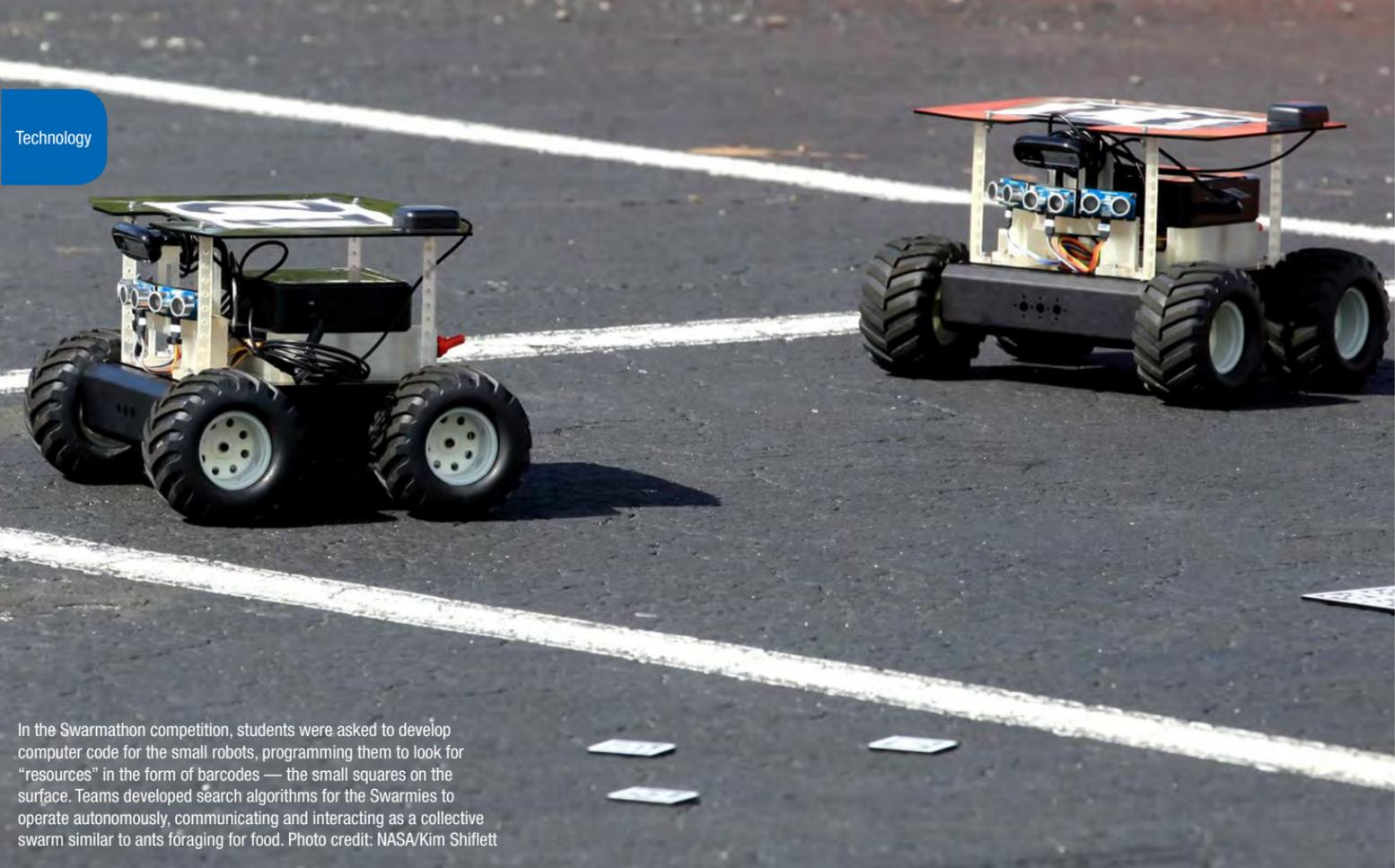


The upper dome of a Boeing CST-100 Starliner is lowered onto the lower dome to complete the first hull of the Starliner's Structural Test Article, a prototype spacecraft that is identical to the operational versions but not meant to fly in space. The work was performed inside the Commercial Crew and Cargo Processing Facility at NASA's Kennedy Space Center in Florida. The STA is built to endure harsh tests mimicking conditions of spaceflight to prove the design and its manufacturing techniques will work for space-bound Starliners. Photo credit: Boeing

build the pressure vessel and then outfit it with electrical and data cables, plumbing and other fittings, those elements are built into the top and bottom halves of the spacecraft. When the domes are joined, the cables and lines and pipes are already in place, saving engineers the time and frustration of having to move everything in through the small hatch and assemble parts together inside the

closed hull.

It is just that kind of manufacturing innovation, along with scores of other examples, that NASA was pursuing in taking on the Commercial Crew Program approach to spacecraft development for the next generation of human-rated vehicles.



In the Swarmathon competition, students were asked to develop computer code for the small robots, programming them to look for “resources” in the form of barcodes — the small squares on the surface. Teams developed search algorithms for the Swarmies to operate autonomously, communicating and interacting as a collective swarm similar to ants foraging for food. Photo credit: NASA/Kim Shiflett

UP TO CODE

Students develop innovative robots in first Swarmathon challenge

BY BOB GRANATH

For NASA’s Journey to Mars, researchers at Kennedy Space Center are developing small robots known as “Swarmies” to help find resources once astronauts arrive at the Red Planet.

The Swarmies were designed through a collaboration between the University of New Mexico and Kennedy’s Swamp Works facility. In research already taking place at the Florida spaceport, computer scientists are developing “Swarmies” focusing not so much on the hardware, but the software. What makes the small robots noteworthy is the coding each carries in its silicon brain that makes them search for useful resources the same way ants do.

In the spaceport’s first annual Swarmathon, students from 12 colleges and universities across the nation were invited to develop software code to operate these innovative robots. The event took

place April 20-21 at the Kennedy visitor complex.

The development of this new form of robotics is another example of transformative capabilities and cutting-edge technologies being developed and tested by the agency today.

This year’s inaugural Swarmathon was won by a team from Fayetteville State University in Fayetteville, North Carolina.

For students participating in the Swarmathon, their work is designed to improve their skills in robotics and computer science, as well as integrating hardware and software. Their developments are helping NASA refine technology for future human space exploration.

In his welcoming remarks, Kennedy’s associate director, Kelvin Manning, pointed out to the students that their endeavors to develop robotic code is more than an academic exercise.

“You will be helping NASA advance our exploration mission,” he said, “One day you may work here too.”

Manning encouraged the students to take advantage of opportunities to speak to NASA engineers and professionals.

“Ask questions,” he said. “That’s what we’re here for – to help you be successful.”

The Swarmathon is part of NASA’s continuing efforts to encourage students to improve science, technology, engineering and mathematics, or STEM, teaching and learning in the United States. It is a joint effort between the University of New Mexico and the space center’s Minority University Research and Education Project (MUREP) STEM Engagement.

The goals of this MUREP program are to increase the number of NASA-focused STEM experiences that engage underrepresented groups



Kennedy Space Center Associate Director Kelvin Manning welcomes students from 12 colleges and universities from across the nation April 20. The spaceport’s first annual Swarmathon challenged students to develop software code to operate the innovative robots. Photo credit: NASA/Kim Shiflett

in active education and to disseminate innovative practices and programs in STEM teaching and learning. Additional objectives include increasing the number of undergraduate and graduate degrees in NASA-related fields awarded to students from minority-serving institutions.

Theresa Martinez, MUREP STEM Engagement manager in Kennedy’s Education Projects and Youth Engagement Office, believes the effort will provide valuable experience for young researchers and help NASA develop crucial technology for planetary exploration.

“The Swamathon is designed to challenge students to refine their software coding abilities and develop new algorithms,” she said. “As someone who works in NASA Education and has an engineering degree, I definitely believe this is a win-win for both NASA and the students.”

Algorithms are self-contained, step-by-step operations to perform calculation, data processing and automated reasoning.

In the Swamathon, students were asked to develop computer code for the small robots, programming them to look for “resources” in the form of barcodes.



In the preliminary round of the Swarmathon competition, three robots searched an approximate 15-by-15-meter walled arena for up to 256 resources over a period of 30 minutes. The college and university teams earned points each time a Swarmie found a "resource" in the form of a barcode. Photo credit: NASA/Kim Shiflett

The principal investigator for the event is Melanie Moses, Ph. D., an associate professor of computer science at the University of New Mexico.

"Our lab has worked for a number of years understanding algorithms that nature uses to solve problems," Moses said. "For example, we studied ant colonies and how ants communicate to develop an emerging swarm. We apply what we learn in biologically inspired computation to swarm robotics."

Moses is helping young engineers focus on the advancement of computer systems.

"Students are learning not just how to program and manage a large software project, but also how to write code that works in the real world," she said. "They also are learning that teamwork, creativity and ingenuity often is way more important than what you learn in class."

The Swarmathon competition provides students an opportunity to put their research to the test.

"Each student team attempted a new algorithm," Moses said. "Some are taking algorithms that others have suggested and testing them in the real world. Many students have come up with clever tricks and elegant, simple solutions that can be implemented on these fairly rudimentary robots."

Building on the research conducted at the University of New Mexico, the engineers at Kennedy have been developing programs that tell small, wheeled Swarmie robots to go out in different directions to search an area for useful materials. In the future,

finding resources available at a planetary landing site may help astronauts practice in-situ resource utilization (ISRU), that is, harvesting and relying on available raw materials as they explore deep-space destinations.

Moses believes the student project could lead to mastering this innovative technology.

"The Swarmathon will harness student creativity to solve difficult and complex problems," she said. "This is an incredible opportunity for students to develop technologies to explore our world and beyond."

For the competition, selected teams were provided three Swarmie robots, training and instruction, and the opportunity to compete against other teams for a \$5,000 cash prize.

The task assigned to the teams from the colleges and universities represented fits right in with what NASA scientists are already doing.

In the Swarmathon competition, teams developed search algorithms for the small robots to operate autonomously. Swarmies were programmed to communicate and interact as a collective swarm, similar to ants foraging for food. During the competition, the teams' algorithms operated the Swarmie robots in an official competition arena. Groups were ranked by the number of resources their search algorithm located in a specified period of time.

In the preliminary round, three robots searched an approximate 15-by-15-meter walled arena for up to 256 resources over a period of 30 minutes. During the final rounds, six robots searched an



The team from Fayetteville State University in Fayetteville, hold their gold trophy and a \$5,000 check for their first place finish in the inaugural NASA Swarmathon. From the left are team members Tyrone Thomas-Wesley, Nathaniel Spindler, Syrus Gaddy, Michael Backus, James Fisher, Samuel Ndiwe, along with faculty mentor Sambit Bhattacharya, Ph.D. Photo credit: NASA/Bill White

approximate 22-by-22-meter walled arena for a maximum of 256 resources during one hour.

The level of difficulty was based on the fact that during the competition teams were not allowed to communicate with their robots. All robot actions were required to be preprogrammed and autonomous.

As a follow-up to the Swarmathon, a Research Exchange for Undergraduates Program has matched students from Swarmathon teams with faculty mentors from other Swarmathon teams for an eight-week summer research project.

After faculty mentors propose a Swarmathon-related research project, students indicate what kind of projects they are interested in and what kind of skills they have to contribute. The Swarmathon evaluation team will choose five students and pair them with five faculty mentors.

The challenges of NASA's exploration vision will require an extended human presence on lunar and planetary surfaces. Using available in-situ resources will benefit both robotic and human missions.

Throughout history, pioneers had to live off the land when exploring new territories. NASA engineers and scientists now are developing capabilities needed to find resources once astronauts reach destinations such as an asteroid, the moon or Mars.

Eventually, robot swarms developed by today's students could be used on other planets, as well as on Earth, for resource use and exploration.

As NASA expands human presence in the solar system, such as

The team from Fayetteville State University in Fayetteville, hold their gold trophy and a \$5,000 check for their first place finish in the inaugural NASA Swarmathon. From the left are team members Tyrone Thomas-Wesley, Nathaniel Spindler, Syrus Gaddy, Michael Backus, James Fisher, Samuel Ndiwe, along with faculty mentor Sambit Bhattacharya, Ph.D. Photo credit: NASA/Bill White

the Journey to Mars, the goal of the Swarmathon competition is to develop integrated robotic platforms that could revolutionize space exploration through the utilization of extra-planetary resources.



IN A DAY'S WORK

Students trade school day for workday at Kennedy Space Center

BY ANNA HEINEY



Kennedy Space Center Director Bob Cabana, right, watches as children prepare to launch air rockets at the Florida spaceport on Take a Child to Work Day. Photo credit: NASA/Kim Shiflett

Twelve-year-old Ethan Neuerburg took a break from visiting spaceflight processing facilities and cutting-edge laboratories long enough to check out the television studio at Kennedy Space Center.

Normally, the aspiring NASA mechanical engineer would be in school instead of accompanying his mother, Wendy Neuerburg, of Kennedy's Center Planning and Development Directorate. But this was Take a Child to Work Day, and Ethan was one of hundreds of local children to take advantage of the rare opportunity to trade in their pencils and homework for a day at the space center.

"So far, we've visited the Space Station Processing Facility, Launch Pad 39B, and the mobile launcher, and we're going to the Vehicle Assembly Building next," Ethan said, listing the places he'd seen engineering in action so far.

Kennedy held its Take a Child to Work Day in conjunction with the national Take Our Sons and Daughters to Work Day. The April 28 event allowed children across the country to accompany their parents, relatives or other sponsors into the workplace to see firsthand the connection between what they're learning in school today and where it

could lead their careers.

As the nation's premier launch center and one of NASA's proving grounds for the journey to Mars, Kennedy is well-positioned to highlight the parallels between aerospace careers and the students' own lessons in science, technology, engineering and math.

"I hope they learn how fun it is to work out here, and how important the work we do here is for everyone on Earth," said Matthew English, a NASA configuration management specialist in Kennedy's Exploration Research and Technology Programs office. English was stationed in the Space Station Processing Facility's high bay, where he chatted with kids and pointed out a floor marker that helped visitors get a feel for the 361-foot length of the orbiting laboratory.

"I love seeing the look on their faces when they learn how big the station is," he said.

Jenni Rivera, program manager for the center's Engineering Services contract, brought her 14-year-old, Melanie.

"She's very interested in the space program, and I'm hoping she'll

have a career out here," Rivera said.

"This gives her an overview of what we do out here in addition to what they learn in school. It's more hands-on," she added.

Kennedy was ready to capture the children's imaginations with a full day of programs, demonstrations and tours designed to give them a wide range of experiences. A "Gee Whiz" presentation by the NASA Education Office explained how astronauts live and work in space, while the Launch Services Program gave kids the chance to learn the fundamentals of rocketry as they built and launched air rockets. The Protective Services team and their K-9 crew even showed what it takes to keep the center's valuable space hardware, one-of-a-kind facilities and stellar workforce safe and secure.

The future of space exploration also was on full display. NASA's Space Launch System rocket will be assembled and launched in Launch Complex 39, where a driving tour took kids and their grown-up sponsors past the mobile launcher, crawlerway and Launch Pad 39B. Commercial Crew Program experts chatted with children about

the spacecraft and rockets needed for deep-space exploration and access to the station. Lockheed Martin showcased its Orion spacecraft and Boeing featured its CST-100 Starliner module.

Ten-year-old Addison Justice joined his father, KSC TV Producer Michael Justice, in the center's television studio for part of the day, between tours and visits to other facilities.

"I like the cameras," Addison said, noting that he and other children had put on a little show. "The cameras are a fun-filled thing!"

One of the long-term goals of Take a Child to Work Day is to spark an "aha" moment in the minds of children. English recalled visiting Marshall Space Flight Center in Alabama with his father.

"Ever since then, I always wanted to work for NASA," English said.

It was a fun day for all, regardless of where their dreams may carry them.

"I was happy to go with my dad and spend some time with him," Addison said, giving his dad a high-five.

SAFETY FIRST

TOSC Safety Week focuses on culture of caring

BY BOB GRANATH

In basketball, a slam dunk is worth two points. In a forklift rodeo at Kennedy Space Center, its value is much more. It helps demonstrate the driver is an expert in safely operating a machine that can present hazards if not used properly.

The forklift rodeo was one of many activities taking place during Jacobs' Safety Week, May 2-6, 2016. The company is the prime contractor for the agency's Test and Operations Support Contract (TOSC) at the spaceport.

According to Jim LaRocque, Jacob's director of Safety and Mission Assurance at Kennedy, the emphasis on safety is all about instilling a culture of caring and to aid in mitigating workplace risks and preventing accidents.

"Safety Week is an annual, companywide activity to stress that people are our greatest asset," he said. "We believe every accident is preventable. This week's activities are part of our efforts to put tools in place to mitigate the hazards that are inherently present in processing vehicles for spaceflight."

Jacobs is providing overall management and implementation of ground systems capabilities, flight hardware processing and launch operations at the spaceport.

Working with the Jacobs TOSC team are subcontractors Engineering Research and Consulting Inc. (ERC), and Aerodyne Industries. They provide support for the International Space Station Program, Ground Systems Development and Operations activities, Space Launch System rocket, Orion spacecraft and Launch Services Program.

The TOSC team's emphasis on safety is designed to address risks and improve further on a national trend toward safer places to work.

According to OSHA — the Occupational Safety and Health Administration — before the agency was created 43 years ago, an estimated 14,000 workers were killed on the job every year. Today, workplaces are much safer and healthier, going from 38 fatal injuries a day to 12.

"Making a living shouldn't have to cost you your life," said David Michaels, Ph.D., assistant secretary of Labor for Occupational Safety and Health. "Workplace fatalities, injuries and illnesses are preventable. Safe jobs happen because employers make the choice to fulfill their responsibilities and protect their workers."

LaRocque explained that his company has done just that making safety a paramount concern. The Jacobs approach focuses on filtering responsibility from the top down.

"The corporation gives responsibility for safety to our program

manager, Andy Allen," he said. "Andy, in turn, expects his directors, managers and supervisors to communicate our 'culture of caring' down to each employee. Our approach expects team members to watch out for each other, encouraging everyone to feel empowered to speak up whenever needed."

LaRocque pointed out that employees will be urged to take at least two hours to visit exhibits or attend activities taking place around the space center.

Joseph Degano of TOSC Safety led a discussion during the week on "Peer Pressure and Safety Behavior." He noted that in the workplace, peer pressure can be positive or negative and can

"Just like we want our astronauts to fly and return safely to Earth, we want our TOSC team members to come to work, do their jobs in a safe environment and go home unharmed to their families at the end of the day."

**—Jim LaRocque
Jacob's Director of Safety
and Mission Assurance**

influence safety behavior. Employees were encouraged to have the "courage" to speak up when they witness an activity that appears unsafe.

"We want our employees to feel comfortable encouraging fellow employees to be safe," LaRocque said, "Likewise, when someone receives a safety reminder, we want that person to know it's because we truly care for each other."

A highlight of the TOSC Safety Week was the forklift rodeo. The points-based competition consisted of forklifts being driven through obstacle courses with skills challenges. These included lifting and stacking items on a pallet.

The "hotshot" basketball challenge involved picking up a basketball with the fork, moving to a basketball goal and carefully moving the lift to allow the ball to drop in the hoop. While a fun activity, the "rodeo" was designed to foster proper safety precautions because, as LaRocque notes, forklifts have inherent dangers of tipping over if not operated properly.



In the parking lot of the Vehicle Assembly Building at Kennedy Space Center, spaceport employees watch a Pike Live Line high voltage demonstration. Pike's live line truck provides an opportunity for the company's safety experts to demonstrate electrical hazards, safe work procedures, along with the proper use and limitations of personal protective equipment.
Photo credit: NASA/Dimitri Gerondidakis

In the forklift rodeo, Fred Parisi, a technician with Engineering Research and Consulting, gets “nothing but net” as he delivers the basketball to the hoop. ERC is a subcontractor under the Test and Operations Support Contract for Jacobs Technology. The forklift rodeo was designed to foster proper safety precautions because of the inherent dangers of a forklift tipping over if not operated properly. Photo credit: NASA/Bob Granath



A Kennedy Space Center employee participates in a distracted driving demonstration. After an undistracted driving run, the participant will spin the “Wheel of Distraction” to determine which driving disruption he will be tasked with. The impact on performance will demonstrate the hazards of distracted driving. Photo credit: NASA/Dimitri Gerondidakis

Another activity was a distracted driving demonstration.

Using a simulator, participants completed a driving video course. The first run was without distractions. After that, the participant would spin the “wheel of distraction” to determine which driving distraction he or she would be tasked with, such as texting, reading or fatigue — simulated using special “fatigue goggles.” The driver then tried to perform the driving simulation with the identified distraction. The results dramatically demonstrated the potential results of distracted driving.

LaRocque noted that Jacobs is taking a proactive approach to protecting TOSC team members’ hearing.

Safety Week included a Hearing Conservation Roadshow. Displays involved demonstrations of engineering controls and examples of quiet tool technology. Personal protective equipment (PPE) on display included examples of electronic hearing protection.

“Our approach is to ‘design quiet or buy quiet,’” he said. “If

we are building a piece of equipment, we want it to run the least amount of noise as possible. Or, if we are buying a power tool or a machine, we consider which produces the least noise. It’s all about taking into consideration employees’ hearing.”

Pike, one of the largest providers of energy solutions in the U.S., presented their Live Line high-voltage demonstration in the parking lot of the Vehicle Assembly Building. The activity provided an opportunity for the company’s safety experts to demonstrate electrical hazards, safe work procedures, along with the proper use and limitations of PPE.

“While many of the Safety Week activities are designed to be fun, our overall messages are serious,” LaRocque said. “Safety is paramount. Just like we want our astronauts to fly and return safely to Earth, we want our TOSC team members to come to work, do their jobs in a safe environment and go home unharmed to their families at the end of the day.”

TURTLE Q&A

DARK SKIES

It is sea turtle nesting season once again along Florida's Space Coast. Sea turtle nesting and hatching season in Florida generally runs from May to November. These gentle creatures need dark skies and that means lights out in the evening, not just at Kennedy Space Center but all along the eastern seaboard of Florida.

How many species of turtles and tortoises are there at KSC?

Do we know how many total of each species there are at KSC?

There are 11 native species of turtles and tortoises documented on KSC, plus 4 species of sea turtles. There have been a few individual African spurred tortoises found here, but they were released (illegally) and have not established a reproducing population. As far as how many of each species – not a clue!

What is the biggest difference between the two?

The term "turtle" refers to those reptiles that are characterized by having a shell. "Tortoise" is a layman's term used to describe a turtle that lives on the land. However, not all turtles that live on the land are called tortoises, for example, the box turtle. So, the best way to remember turtles vs. tortoises is that all tortoises are turtles, but not all turtles are tortoises.

What should you do should you come across one on the road (take to the side they were crawling to)?

The best thing to do is look for accessible nearby habitat and put it there. Taking the turtle toward whatever direction it is pointing may not be the best thing to do, for the turtle or you. Safety first! And remember that, even though turtles don't have teeth, if they chomp you, it will hurt.

What are some of the things KSC/Wildlife Refuge does for turtles and tortoises on KSC property? Do you track them in any way?

Most of our turtle work focuses on gopher tortoises because they are protected by the State and are a candidate for federal listing under the Endangered Species Act. Whenever any construction, demolition, or maintenance work is done, we make sure that tortoises are not impacted, or we take measures to protect them. In addition, we have several tortoises radiotagged so we can determine their use of the new dune NASA built along our coast in 2014.

Does KSC work with sea turtles?

Some of the research on sea turtles is conducted by U.S. Fish and Wildlife Service personnel from Merritt Island National Wildlife Refuge. They keep track of the numbers of nesting females each year and the success of the nests. The KEMCON Ecological Program conducts netting surveys for turtles twice a year in the Indian River Lagoon System.

To find out what you can do to help, watch this video:
<http://go.nasa.gov/1TAsFF9>

PRESTIGIOUS PAIR

Hall of Fame welcome pair of space shuttle astronauts

BY BOB GRANATH



At NASA's Kennedy Space Center Visitor Complex, space shuttle astronauts Brian Duffy, left, and Scott Parazynski, congratulate each other after being inducted into the U.S. Astronaut Hall of Fame. Photo credit: NASA/Kim Shiflett

Space shuttle astronauts Brian Duffy and Scott Parazynski joined an elite group of American space heroes as they were inducted into the U.S. Astronaut Hall of Fame. They were welcomed to the ranks of legendary pioneers such as Alan Shepard, Neil Armstrong and Sally Ride during a May 14 ceremony at the Kennedy Space Center Visitor Complex.

Since the Hall of Fame inducted the seven Mercury astronauts in 1990, these additions bring the number of enshrined space travelers to 93.

Former CNN reporter and veteran space correspondent John Zarrella, served as master of ceremonies and introduced the 20 attending members of the Astronaut Hall of Fame.

NASA Administrator and Hall of Fame astronaut Charlie

Bolden honored the two current inductees, looking to the agency's next leap forward.

"Today NASA is on the Journey to Mars that will take our astronauts to an asteroid next decade and the Red Planet in the 2030s," he said. "When our astronauts put the first human footsteps on Mars, they will be walking in the footsteps of hall of famers like Brian Duffy and Scott Parazynski."

Bolden also paid tribute to the workforce at the Florida spaceport.

"The team here is hard at work every day transitioning the Kennedy Space Center to a premier multi-user spaceport," he said.

Hall of fame astronaut Kevin Chilton introduced Duffy, describing him as "a quiet unassuming leader."

Duffy stated that being selected for this honor was "the greatest recognition of my professional career."

Growing up near Boston, in Rockland, Massachusetts, Duffy recalled being a baseball enthusiast, following the Red Sox and their chief rival, the New York Yankees.

Duffy pointed out that he could relate to a statement legendary Yankee catcher Yogi Berra made when he was inducted into the Baseball Hall of Fame in 1972.

"The first thing I should do is thank those who made this day necessary," Duffy quoted Berra as saying.

Duffy explained that he understood what Berra meant by one of his seemingly unintentional witticisms, also known as "Yogi-isms."

"We're all shaped by the people who touched our lives," Duffy said.

Discovery on a mission to the International Space Station.

Duffy expressed appreciation for the people who helped with the achievements on his space shuttle missions.

"The successes I experienced in the Shuttle Program would not have happened without the absolute commitment of thousands of people across the country," he said.

He directed much of his praise to the workforce at Kennedy.

"All of the preparations come together here," he said. "Over time, I realized how proud the Kennedy workforce was of their orbiter fleet. Each time they gave us a perfect, clean, beautiful machine."

Today, Duffy is Orbital ATK's vice president and program manager, leading the company's human space exploration activities at Kennedy and the Johnson Space Center in Houston.

"When our astronauts put the first human footsteps on Mars, they will be walking in the footsteps of hall of famers like Brian Duffy and Scott Parazynski."

**- Charlie Bolden
NASA Administrator
and Hall of Fame astronaut**



NASA Administrator and Hall of Famer Charlie Bolden speaks at the ceremony during which Brian Duffy and Scott Parazynski were inducted into the U.S. Astronaut Hall of Fame. Photo credit: NASA/Kim Shiflett

"It's truly a humbling experience to be joining my heroes," he said pointing to hall of fame astronauts in attendance whose exploits date back to the Apollo era. "These are the folks I watched as I was growing up."

After graduation from the U.S. Air Force Academy, Duffy gained extensive experience as a test pilot, including over 5,000 hours in more than 25 different aircraft, before becoming an astronaut.

Following astronaut candidate training, Duffy worked in Mission Control as a spacecraft communicator. He also assisted in developing instrumentation displays and flight crew procedures for use on later shuttle flights.

Duffy began putting these experiences to work on his first flight assignment in 1992 as pilot of STS-45 and STS-57 the following year. In 1996, he was commander of the STS-72 flight of the shuttle Endeavour. In 2000, Duffy commanded the STS-92 crew of

Kent Rominger, also a hall of fame astronaut, introduced Parazynski, noting that he is not only an astronaut, but also the first person to orbit the Earth and later climb to the summit of Mount Everest.

"There is no opportunity, especially if it is an adventure, that he is going to pass up," Rominger said. "He is truly an explorer."

Like Duffy, Parazynski expressed appreciation for being counted with earlier astronauts "who have been my inspiration since I was a little kid."

"I am so deeply honored and humbled to be here today to receive this recognition, not as an individual," he said, "but on behalf of literally the thousands of people who touched my professional career."

Born in Little Rock, Arkansas, Parazynski considers Palo Alto,



STS-72 commander Brian Duffy is seen at the controls of the Space Shuttle Endeavour during rendezvous operations with the orbiting Japanese Space Flyer Unit during Jan. 11-20, 1996. Photo credit: NASA

California, and Evergreen, Colorado, to be his hometowns.

After earning a bachelor's degree from Stanford University, Parazynski went on to Stanford Medical School. Following a medical internship, he completed 22 months of residency in emergency medicine in Denver, Colorado. In 1992, he was selected as a NASA astronaut.

Parazynski flew five space shuttle missions and participated in seven spacewalks. His shuttle missions include serving as a mission specialist on STS-66 in 1994 and STS-86 three years later, including a rendezvous with the Russian space station Mir.

Parazynski also had high praise for those who supported the Space Shuttle Program.

"They are brilliant, resourceful, creative, passionate professionals at NASA and the contactors," he said. "Men and women — Americans and international partners — who prepared our spacecraft, our payloads, trained us for the adventurous missions into space, launched our ships from the Kennedy Space Center, led the flights from the Mission Control Center and then safely brought us back to planet Earth."

In 1998, Parazynski was named to the STS-95 crew, which included Astronaut Hall of Fame charter member John Glenn.

"My gosh, I'm going to have a chance to fly with my boyhood

hero," Parazynski said upon being given the news. "That was such an extraordinary experience to fly not only with a legend, but a great human being."

Using his medical background, Parazynski monitored several life sciences investigations, including those involving Glenn.

STS-100 in 2001 and STS-120 six years later were both flights to the International Space Station. Altogether, Parazynski spent over 57 days in space.

Following his fifth spaceflight, Parazynski retired from NASA in 2009 to work in industry and to pursue other interests, such as scaling Mount Everest. He also served as honorary captain of the U.S. Olympic Luge Team during the 2010 winter games in Vancouver, Canada.

In the 1980s, the six surviving Mercury Seven astronauts and Gus Grissom's widow, Betty Grissom, conceived the idea of a place where U.S. space travelers could be remembered and honored. The Mercury Seven Foundation and Astronaut Scholarship Foundation were formed and have a role in operations of the Hall of Fame, which opened its doors in 1990. The scholarship foundation presents numerous scholarships each year, and since its inception has awarded nearly \$4 million to more than 400 college and university students who exhibit motivation, imagination, and exceptional performance in the fields of science and engineering.



STS-100 mission specialist Scott Parazynski was photographed by a crewmate inside the space shuttle Endeavour during one of the two space walks during the mission to the International Space Station. Photo credit: NASA

PROJECT GEMINI

PART 6



"What a beautiful spacecraft," said Eugene Cernan during his spacewalk. He took this wide-angle photograph looking back at the window where Tom Stafford was watching. Photo credit: NASA/Eugene Cernan

Gemini IX crew finds 'Angry Alligator' in Earth orbit

BY BOB GRANATH

NASA's Gemini IX mission was another step in developing technology for future spaceflights from Apollo to the agency's Journey to Mars. But this mission included developing alternate plans when faced with the unexpected.

Gemini IX provided NASA with crucial experience in learning how to be flexible, expanding skills in orbital rendezvous and gaining a better understanding of the challenges faced by

being completed.

The backup crew of Tom Stafford as command pilot and Eugene Cernan as pilot then were named for the upcoming flight. A veteran of Gemini VI the previous year, Stafford would go on to command Apollo 10 in 1969 and the Apollo-Soyuz mission in 1975.

Cernan was lunar module pilot with Stafford on Apollo 10 and commanded the final moon landing mission, Apollo 17, in



After two postponements, Gemini IX astronauts Eugene Cernan, left, and Tom Stafford, center, arrive in the white room atop Launch Pad 19 at Cape Kennedy Air Force Station on June 3, 1966. Stafford is presenting a large match to McDonnell Aircraft Corporation's pad leader Gunter Wendt, far right. Stafford "instructed" Wendt in jest to "light the fuse today." Between Stafford and Wendt are the backup crew, Buzz Aldrin and Jim Lovell. The Gemini spacecraft did lift off later that morning atop a Titan II rocket. Photo credit: NASA

spacewalking astronauts.

The three-day mission was designed to be similar to the previous flight in March 1966. After achieving the first orbital docking, Gemini VIII was brought home early due to a failed spacecraft thruster. The Gemini IX crew hoped to gain further experience in rendezvous, docking and working outside the capsule. Plans also called for performing a complex spacewalk using a self-contained rocket backpack, called the Astronaut Maneuvering Unit, or AMU.

The original Gemini IX command pilot was scheduled to be Elliot See, with Charles Bassett as pilot. They were both killed on Feb. 28, 1966, when their T-38 jet crashed into the McDonnell Aircraft plant in St. Louis, where assembly of their spacecraft was

December 1972.

Gemini IX's Agena target vehicle was launched by an Atlas rocket on May 17, 1966. Stafford and Cernan were already aboard their spacecraft poised to lift off 90 minutes later as the Agena competed its first orbit. However, the Atlas malfunctioned in flight, and the Agena failed to reach orbit.

Launch of Gemini IX would have to wait.

Even so, Dr. George Mueller, NASA associate administrator for Manned Space Flight, had high praise for the launch team, noting that the simultaneous countdowns at Cape Kennedy Air Force Station's Launch complexes 14, for the Atlas-Agena, and 19, for the Gemini-Titan, had been the "smoothest yet in the Gemini

An Augmented Target Docking Adapter, or ATDA, launches atop an Atlas rocket from Cape Kennedy Air Force Station's Launch Complex 14 on June 1, 1966. The ATDA served as a rendezvous target for Gemini IX. Photo credit: NASA



Program.”

While the next Agena would not be available until summer, NASA had a backup rendezvous target available, called an Augmented Target Docking Adapter, or ATDA. Additionally, the mission was redesigned Gemini IXA.

“We had a flexible flight plan allowing us to shift around items and that’s exactly what happened,” said Stafford.

The contingency target vehicle was developed after an Agena failed to reach orbit for the original Gemini VI mission. This spacecraft would allow Gemini flights to continue without delaying the goal of landing on the moon before the end of the decade of the 1960s.

The ATDA was built by the McDonnell Corp., prime contractor for the Gemini spacecraft. The ATDA used a Gemini spacecraft re-entry control section and other already proven equipment. Like the

Agena, it was launched atop an Atlas rocket on June 1, 1966, and successfully reached an orbit 161 miles above the Earth.

However, telemetry soon indicated more unexpected news. The conical nosecone shroud at the top of the ATDA appeared not to have separated. If that was the case, docking would be impossible as the shroud covered the target vehicle’s docking collar.

After a two-day delay, Stafford and Cernan were launched on June 3, and they would soon learn the condition of the shroud.

Stafford fired his thrusters 49 minutes after liftoff to begin closing in on the ATDA. Radar contact was achieved when the two space vehicles were 150 miles apart. Stafford and Cernan spotted the ATDA at three hours, 20 minutes into the mission, when they were 58 miles away.

As they closed in, Stafford began to describe what they saw.

“We’ve got the ATDA in reflected moonlight at about 3 1/2 miles,” he said.

As they closed in at about 900 feet, Stafford reported his first good view of the ATDA.

“That’s a weird looking machine,” he said. “Would you believe that there’s a nose cone on that rascal. The shroud is half open. It looks like an angry alligator out there rotating around.”

The shroud was supposed to open in two halves and drop away during launch. It split in two, but was hung up at the base. While the rendezvous was successful, the alligator-like “jaws” would prevent docking unless there was a way to push it aside.

“You could almost knock it off,” Cernan said.

Stafford suggested to spacecraft communicator Neil Armstrong in Mission Control Houston that they be allowed to extend a docking guide bar on the nose of the Gemini to gently bump the shroud in an attempt to knock it off.

Armstrong, who commanded the previous flight, relayed word that Flight Director Eugene Kranz vetoed the idea as too risky.

While the docking was ruled out, Stafford and Cernan gained valuable experience and data on different approaches to rendezvous, a maneuver that would be crucial as Apollo astronauts in a lunar module returned to the command module after exploring the moon.

Gemini IXA performed a second rendezvous moving away from the ATDA and then successfully completed an approach from below. It also was the first pure optical rendezvous.

“Gene made all the computations and we did not use the computer,” Stafford said. “We wanted to test how good man can visually judge distance.”

This required learning how to best interpret visual cues.

“We had anticipated that silver paint (on the ATDA) actually would be almost equivalent to white in visual acquisition, but it certainly was not,” Cernan said. “We could more easily see the white shroud in reflected moonlight.”

At one point, the Gemini IXA crew used an onboard system to verify Stafford’s estimation that they were about one mile from the ATDA.

“The radar said we were at 1.1 mile,” he said. “It was obvious we could judge distance in close.”



During his two hour, eight minute spacewalk on June 5, 1966, Gemini IX pilot Eugene Cernan is seen outside the spacecraft. His experience during that time showed there was still much to be learned about working in microgravity. Photo credit: NASA

“That’s a weird looking machine. Would you believe that there’s a nose cone on that rascal. The shroud is half open. It looks like an angry alligator out there rotating around.”

–Tom Stafford
Gemini IX Command Pilot



The Augmented Target Docking Adapter, or ATDA, as seen from the Gemini IX spacecraft during one of their three rendezvous in Earth orbit. Failure of the docking adapter protective cover to fully separate on the ATDA prevented the docking of the two spacecraft. As a result, command pilot Tom Stafford described the ATDA as looking like an “angry alligator.” Photo credit: NASA



Shortly after reaching orbit on June 3, 1966, Gemini IX command pilot Tom Stafford is seen at the controls during the mission to rendezvous with an Augmented Target Docking Adapter. Photo credit: NASA/Eugene Cernan

On flight day two, they approached the ATDA a third time, simulating a lunar module returning to the command module in lunar orbit. They learned that the rendezvous radar would be required for this approach.

Stafford then backed off from the target vehicle to prepare for the next day's ambitious spacewalk.

During America's first spacewalk a year earlier, Gemini IV astronaut Ed White floated around for 20 minutes. Cernan planned more than two hours of task evaluations and work testing the AMU. It was equipped with propulsion, a stabilization system, oxygen and telemetry for biomedical data.

As Cernan floated through the Gemini hatch, he described what it is like being outside.

"Boy, is it beautiful out there, Tom," he said, "and what a beautiful spacecraft."

After his experience on Gemini IV, White recommended handholds to assist future spacewalkers. For Gemini IXA, Cernan tested Velcro for that purpose.

"I started using one of those Velcro pads and I lost it," Cernan said. "It came right off my hand. The Velcro's not strong enough."

Cernan then worked his way back to the aft section where the AMU was located. Once he reached the AMU in the spacecraft's adapter section, Cernan realized his spacesuit provided limited maneuverability. He was unable to gain any leverage for his planned tasks due to the lack of hand and foot holds. It also was difficult to turn valves and perform simple movements.

The extra effort caused the heat to rise in Cernan's spacesuit, and his increased respiration resulted in his helmet visor beginning to fog up.

"He's fogging real bad," said Stafford to officials in Mission Control. "The AMU controller arms presented far more difficulty to us in zero *g* than they did in the simulation."

With Cernan barely able to see, Stafford and mission control agreed to bring him back in after two hours and eight minutes outside the spacecraft.

The next day, June 6, Stafford and Cernan fired Gemini's retro rockets on their 45th orbit of the Earth. They landed less than one mile from the prime recovery ship, the USS Wasp. It was the first time a spacecraft descending on its parachute was shown on live television.

The flight's lessons learned resulted in NASA mission planners adding even more flexibility into future flight plans. On Gemini IXA, Stafford and Cernan were able to work with flight controllers to demonstrate sophisticated rendezvous maneuvers were workable and applicable to Apollo and future space programs. Cernan's experiences on his spacewalk showed there still was much to be learned about working in microgravity outside a spacecraft.

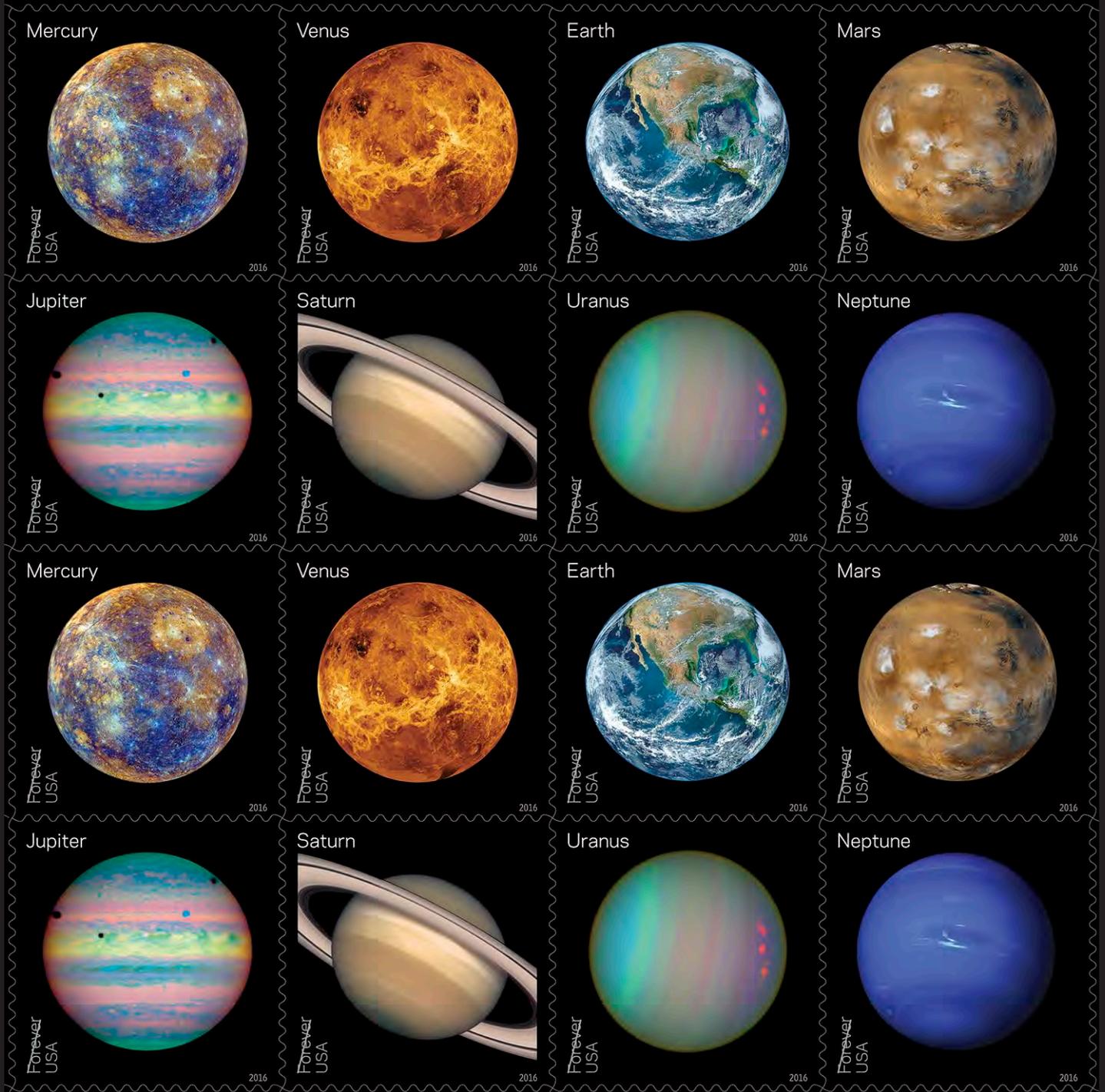
"We came back with some data and recommendations on how to handle yourself when floating in close proximity to the spacecraft," Cernan said in the postflight news conference.

As a result of Cernan's experience, important changes were made for planning future work outside a spacecraft, including adjustments to the workloads for future Gemini spacewalks. For Apollo moonwalks, the spacesuits were designed differently.

A Gemini spacesuit was cooled by air flow. Apollo spacesuits for moonwalkers and for those astronauts who work outside today's International Space Station would be cooled by having the astronaut wear an undergarment with small tubes circulating water near the skin.

EDITOR'S NOTE: This is the sixth in a series of feature articles marking the 50th anniversary of Project Gemini. The program was designed as a steppingstone toward landing on the moon. The investment also provided technology now used in NASA's work aboard the International Space Station and planning for the Journey to Mars. In July, read about an orbital rendezvous with two separate spacecraft. For more, see "On the Shoulders of Titans: A History of Project Gemini."

Views of Our Planets



"Views of Our Planets" Forever stamps featuring iconic images of the planets in our solar system, including the well-known "Blue Marble" photo of Earth are now available at a post office near you! Also, new "Pluto Explored" Forever stamps commemorating the July 2015 flyby of Pluto by NASA's New Horizons spacecraft also are being issued for online purchase.

"The unveiling of these breathtaking new images of Pluto and our planets is exciting for NASA and for all who love space exploration, said Jim Green, director of planetary science at NASA Headquarters in Washington. "With the 2015 Pluto flyby, we've completed the initial reconnaissance of the solar system, and we're grateful to the U.S. Postal Service for commemorating this historic achievement."

National Aeronautics and Space Administration

John F. Kennedy Space Center
Kennedy Space Center, FL 32899

www.nasa.gov